

POPULAR SCIENCE

JAN. 1946
25 CENTS

MONTHLY



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**HERE IT IS
THE MOST USEFUL**

Here, in one great, brand-new volume is **EVERYTHING** you need to know to do **ANY** job in or around your home—repairs, alterations, improvements, and new projects.

The Home Mechanic's Handbook

JUST A FEW OF THE PRACTICAL JOBS FULLY DES

How to choose the right paint for every job
Figure the quantity of paint needed
Paint a house—inside and outside
Care for brushes
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Paper a room
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Replace a sash cord
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Screen in a porch
Tighten a loose chair, floor board, stair tread
Fix a window, door, or drawer that sticks
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Build a chicken house, cupboard, workbench, cold-bed frame, storage cabinet
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Fix leaks in faucets and valves
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Install a hot-water heater
Make a flagstone walk, a sidewalk, a wall, concrete steps, a shuffleboard
Build a brick fireplace
Install glass blocks

Install a call-bell system and rear-door system, a door circuit, or a burglar alarm
Locate a short circuit
Repair electrical equipment and appliances

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- **HOME WORKSHOP OWNERS!** You'll find thousands of new ideas, "tricks," practical projects.
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THE
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Handbook***

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315 Pages

Remarkable illustrations show every job and the use of every tool

**BIG... AUTHORITATIVE...
TREMENDOUSLY HELPFUL**

Personal Accident, Health and Hospital Insurance *Direct at Cost*

FOR ALL PREFERRED RISKS, most "white collar" men between the ages of 18 and 54, this strong, 62-year-old company of 212,000 carefully chosen members offers maximum protection per dollar because of the economy of our mutual way of doing business *Direct, At Cost. Not a limited type policy.* You are protected night and day, at home or on trips... at work or at play... *whether your income is affected or not.* We are licensed by the Insurance Departments of New York and Canada.

Here's what you get:

Choice of plans to fit your needs

\$25 or \$50 WEEKLY for TIME LOST through injury by accidental means... payable from the first day every 30 days for as many as 104 weeks... *as much as \$2,600 under the single or \$5,200 under the double plan for any one mishap.* No limit to number of mishaps covered.

\$12.50 or \$25.00 WEEKLY up to 26 weeks for partial disability similarly caused.

\$5,000 or \$10,000 for LOSS OF LIFE, limbs or sight by accidental means.

\$25 WEEKLY for SICKNESS causing confining disability, payable after the first 10 days every 30 days for as many as 52 weeks... *up to \$1,300 for any one confining sickness.* No limit to number of separate sicknesses covered.

\$12.50 WEEKLY up to 26 weeks for non-confining total disability caused by sickness.

Up to \$290 for HOSPITALIZATION: In addition to above allowances, up to \$290 is paid direct to you for hospital room or a nurse in the home, surgery, X-ray, operating room, anaesthesia and laboratory fee, for either accidents or sickness. No conflict with Blue Cross or other group plans.

SEND NO MONEY now, but do mail the coupon below for the FACTS booklet of interesting information and an easy-to-complete blank for applying. If your application were accepted at this time, only \$2 would cover the full cost of the single plan of accident protection until next June; currently \$2.50 quarterly thereafter—moderately more for double accident benefits, health or hospitalization.

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MUTUAL ACCIDENT ASSOCIATION

H. E. Trevvett, Sec'y. UTICA, N. Y. Founded in 1883

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Age..... Occupation.....

[18 to 54]

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NEW B. F. GOODRICH PASSENGER TIRE

New B. F. Goodrich synthetic

TIRE THAT OUTWEARS PREWAR TIRES!

"A MIRACLE," some have called it! Few believed that a tire could ever be made of synthetic rubber that would actually outdistance those made of prewar natural rubber. Yet here it is, the new B. F. Goodrich Silvertown. And here are some of the reasons for its longer-than-prewar mileage:

New, better rubber

A new rubber, so superior that for a long time it was a closely guarded military secret, was developed by B. F. Goodrich. Tires made with this rubber wear longer, run cooler. They have greater resistance to cracking—actually are more resistant to bruising and damage from accidents. But rubber is only one reason why the new B. F. Goodrich Silvertown outwears prewar tires.

New road-level tread

In the picture above, note how the tread is flatter—puts more rubber on the road. This means that

more rubber shares the wear, spreads it evenly over the whole tread surface. No more worn-out-in-the-middle treads. The result: more mileage, better traction, more skid-resistance and greater safety.

The tire body is more rugged, too. B. F. Goodrich developed a stronger cord for this tire. And more cords are used than in prewar tires. Another feature that means more miles, greater safety for you.

Nearly 17 million test miles

Over 2,000 tests have been made with this new tire. Taxi fleets, state police cars, and the B. F. Goodrich test fleet have rolled up nearly 17 million miles under all kinds of driving conditions. The new B. F. Goodrich Silvertown gives longer tread wear . . . actually outdistances prewar tires.

3 years' EXTRA experience

The first B. F. Goodrich tires containing synthetic rubber were

sold to American motorists 18 months *before* Pearl Harbor. That was three full years before any other tire manufacturer . . . three years during which B. F. Goodrich has been piling up extra synthetic rubber tire experience.

This three-year head start is another reason why you can count on extra mileage . . . extra safety . . . extra value from the new B. F. Goodrich Silvertown.

Supplies are still limited, of course, but we hope to have much larger quantities in the hands of most dealers within the next few months. *The B. F. Goodrich Company, Akron, Ohio.*





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Clocks with tiny crystal hearts that beat 100,000 times a second

CRYSTAL HEARTS beat time in Bell Telephone Laboratories, and serve as standards in its electronics research. Four crystal clocks, without pendulums or escapements, throb their cycles without varying by as much as a second a year.

Precise time measurements may seem a far cry from Bell System telephone research, but time is a measure of frequency, and frequency is the foundation of modern communication, whether transmission is by land lines, cable, or radio.

These clocks are electronic devices developed by Bell Laboratories, and refined over years of research. Their energy is supplied through vacuum tubes, but the accurate timing, the controlling heart of

the clock, is provided by a quartz crystal plate about the size of a postage stamp.

These plates vibrate 100,000 times a second, but their contraction and expansion is less than a hundred-thousandth of an inch. They are in sealed boxes to avoid their variation in atmospheric pressure, and temperatures are controlled to a limit as small as a hundredth of a degree.

Bell Laboratories was one of the first to explore the possibilities of quartz in electrical communication, and its researches over many years enabled it to meet the need for precise crystals when war came. The same character of research is helping to bring ever better and more economical telephone service to the American people.



BELL TELEPHONE LABORATORIES *Exploring and inventing, devising and perfecting for continued improvements and economies in telephone service.*

EDITORIAL MEMO

To: *Reader*
From: *Editor*

Down at the bottom of this page is what is called the "masthead." For some reason, magazine staffs are full of what seem to be fictional names. In fact, William Saroyan once had a character in a play intone the whole masthead of Time, Popular Science Monthly, too, has its share of unusual people, some of whom have matching names. You might like to meet some of the faces whose names are familiar:



TORREY

You have seen Volta Torrey's by-line on many a piece in Popular Science which has helped make science popular. His father, an enthusiastically electrical engineer, named him after Alessandro Volta (1745-1827), the Italian scientist whose work gave us electric batteries. Torrey served on the Omaha World-Herald, Chicago Tribune, Cleveland Press, New York Herald Tribune, and PM. In 1939 he leaped from the loud routine of the Associated Press in New York to a Nieman Fellowship at Harvard. Last summer he helped write the report of the U.S. Strategic Bombing Survey—the civilian assessment of air power. In The Rise and Fall of Germany's Chemical Empire (p. 66) he tells how science kept the war machine going so long and how it was destroyed at the bottom by bombing.



NEWMAN

Fred Otis Newman has been one of the mainstays of Popular Science for five years. Before that, he put in ten years on the New York Herald Tribune. Son of a Presbyterian minister, he worked his way through Williams, found himself in Switzerland when Geneva was the bright spot in international relations. He worked with the League of Nations for a couple of years, met an American girl, imported his father to marry them, came back to the U.S. to help get Bennington College started. As a working newspaperman in science, he does a lot of the behind-the-scenes work in making this magazine your magazine.

The name "Alden P. Armagnac" has appeared more frequently in Pop-

ular Science than any other. Although no ancient, he has been a member of the editorial staff for 19 years, joining a year after he left Columbia College and Columbia School of Engineering. His first assignment was to get a photograph of a baboon. Since then, he has cruised on the battleship Iowa and attended atomic sessions with equal aplomb. And he approaches a crackpot invention and the electron microscope with equal sincerity.



ARMAGNAC



SANDERS

Gold Vyron Sanders is another staff member with the broad newspaper background which helps to keep Popular Science articles practical and informative. He has worked with Reader's Digest and the Committee for Economic Development. As a member of the staff of Popular Science, Gold Sanders has specialized in simplifying science for people like myself who like the long words spelled out.

Harry Walton is the kind of man who seems always to have a spare washer in his pocket when a faucet is leaking. As Home & Workshop Editor, he is one of the most important people in the place. Walton can spin a yarn of space-ships or carve a model of a drill press with equal ease. He is a prodigious consumer of peanuts and popcorn—which he carries in his brief case, mixed with manuscripts.



WALTON



GITHENS

My name is not as romantic as Armagnac or as scientific as Volta, but it gets me around—although with some misspelling. It has appeared on the mastheads of Time, Business Week, and the old Life. My grandfather was a good machinist and something of an inventor, but my presence on this masthead is due more to some twenty years in this people-and-paper business which is publishing. My job as editor is to act as your agent with all the writers, researchers, photographers, and artists it takes to give you what you want in this magazine about science and the citizen. Next month I would like to introduce other members of the staff and tell you something of how we work.

EDITOR.....Perry Githens

MANAGING EDITORS:

Fred O. Newman, Volta Torrey
ART EDITORS: Harry Samuels, Michele de Santis
AVIATION EDITOR.....C. B. Colby
HOME & WORKSHOP EDITOR....Harry Walton
ASSOCIATE EDITORS: Edward F. Allen, Alden P. Armagnac, Devon Francis, James L. Freeman, Wesley S. Griswold, Robert Gorman, Hartley E. Howe, Frank Rowsome, Jr., Gold V. Sanders, Leon Shloss, R. P. Stevenson.

ART ASSOCIATES: Michael Carniello, Frances Cooper, Samuel Dukler, William Patrick, Stewart Rouse.

PHOTOGRAPHERS: W. W. Morris, Hubert Lockett
EDITORIAL ASSISTANTS: Elsie E. Brandt, Carol Ennis, David McNamara, Lillian Thalenfeld, Ruth Westphal.

PUBLISHER....Godfrey Hammond





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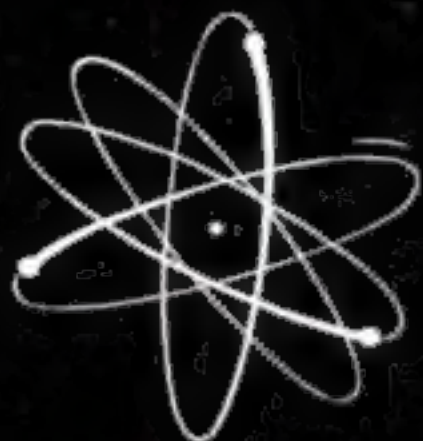
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British residents send coupon to I. C. S., 71 Kingsway, London, W. G. 2, England.

DISCOUNT TO DISCHARGED VETERANS—SPECIAL TUITION RATES FOR MEMBERS OF THE ARMED FORCES

MAN-*The Mortal God*



Unseen Worlds At *Your* Command!

Possibly there are universes beyond this one to be realized. Perhaps within the nucleus of each atom is the energy of a thousand dynamos — awaiting man's command. But for all of this outward conquest, are you still at the mercy of mysterious *indwelling* forces? No man is a master who has not explored self — to whom the worlds of *inspiration*, *mental creating*, and *intuition* remain dark continents of the mind. Would you like to shatter the illusions of time and space — know what is real and what are the oppressing limitations in life? Would you like to *know* the true purpose of your conscious existence — and experience the Cosmic forces which influences it?

ACCEPT THIS *Free* BOOK

Now is the time to discard obsolete, traditional thought. We are on the horizon of a new era. Learn how nature was intended to obey your commands. Write the Rosicrucians, a world-wide fraternity (not a religion), for their fascinating free book, "The Mastery of Life." It will throw new and searching *light* upon you and your universe.

Address SCRIBE: H. T. W.

THE ROSICRUCIANS (A. M. O. R. C.)

SAN JOSE, CALIFORNIA, U. S. A.



IF YOU were Boss would YOU promote “YOU”?

Be honest now—

suppose that a better job had opened up in your company—carrying with it promotion and more money—could you qualify?

If you were boss, would you select “YOU” for that better job?

Consider before you answer.

First of all, could you *fill* the job? Has your experience fitted you for the step forward—have you been preparing for promotion apart from experience gained on the job?

Or have you just been filling a niche, doing daily tasks well but making no real and intelligent effort to learn and qualify for the job ahead so that if an opening should occur you would be ready to fill it?

The man who gets real promotion is the one who makes his own breaks—the man who slaves in the ordinary job at low pay just wishes and dreams of promotion and more money. Which are you?

Business is always willing to pay the man who knows—and pay him well. The man who is ready and willing to take responsibilities—and capable of

directing the efforts of other men is a valuable asset to any business organization. He never wants for a good job and above average earnings. He gets ahead.

We have helped thousands of men achieve promotion and more money—success sometimes beyond their dreams—a success that was started by a coupon similar to the one below.

Get out of that rut—don’t be satisfied with a mediocre job at small pay—be a success in business—this coupon may be your first step.

So send it today—right now—tomorrow never comes for the man who consistently puts things off.

La Salle Extension University A Correspondence Institution

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417 S. Dearborn, Chicago 5

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Position.....

Address.....Zone, if any.....

City and State.....



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National Radio Institute
The man who has directed the Home Study Training of more men for the Radio Industry than any other man in America.

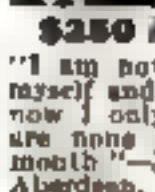
BE YOUR

*OWN BOSS AND
MAKE LARGE PROFITS
WHILE YOU LEARN*

I Trained These Men



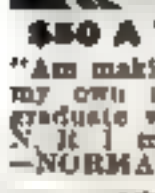
\$35 - \$45 A Week in Own Shop
"Previous to enrolling for your Radio training I made \$12 per week in a hardware store. Now I operate my own repair shop, and often clear \$35 to \$45 a week." **FREDERICK BELL**, 78 Golf Ave., St. John's, Newfoundland.



\$250 A Month in Own Shop
"I am now operating a Radio shop for myself and own all my equipment. Right now I only repair Radios, because there are none to sell, but I average \$250 a month." **J. M. BORIVENER, JR.**, Aberdeen, Miss.



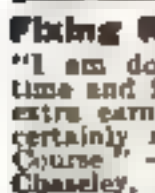
Averages Over \$60 A Week
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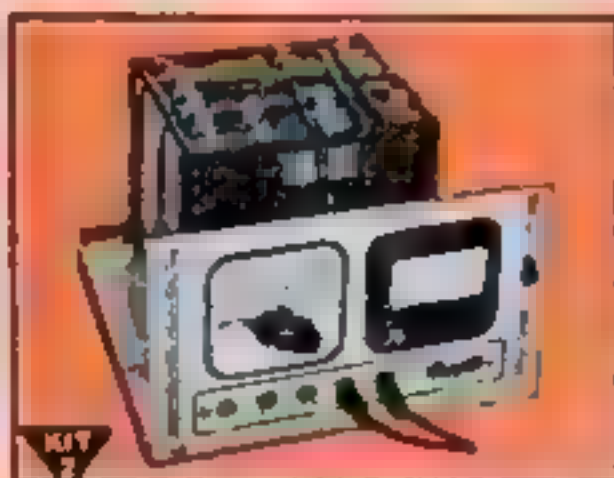
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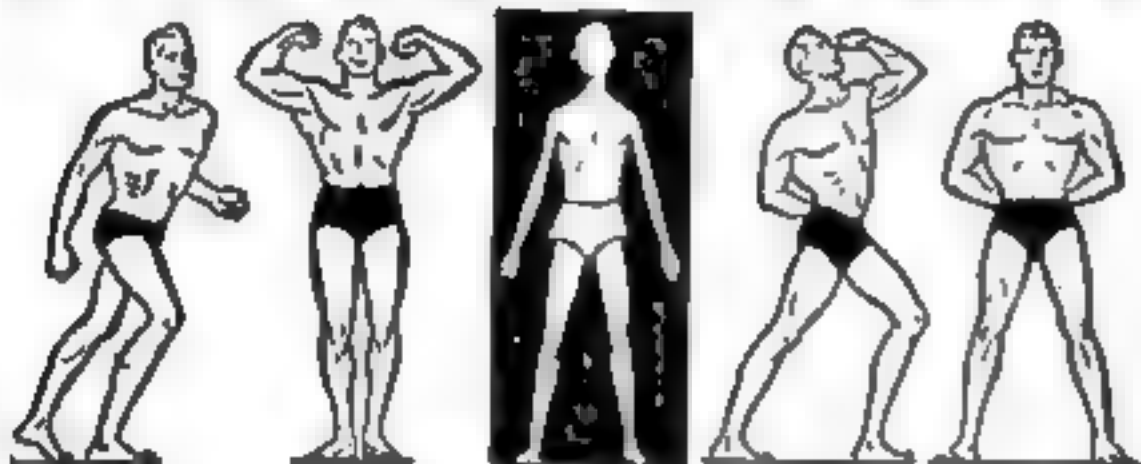
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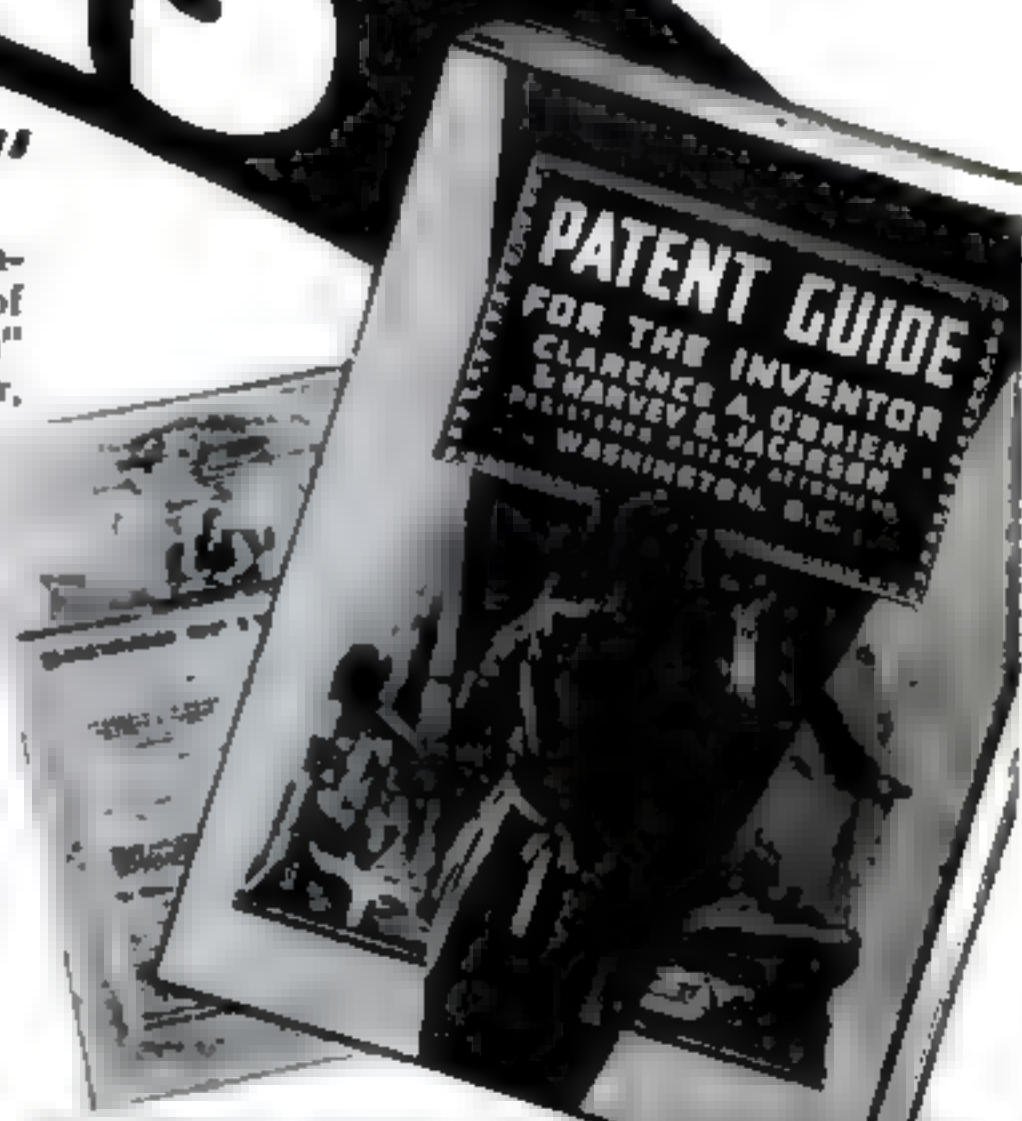
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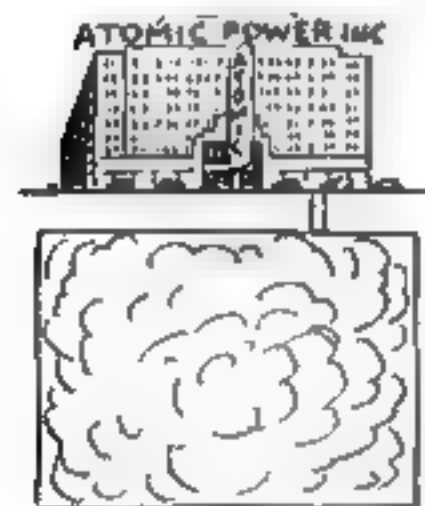
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Some Advanced Thoughts on Atomic Energy

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be possible to detonate dry explosives in compression chambers and release the energy thus created through a system of valves to operate turbines or compressed-air devices? Or, if the gas produced by these explosives is inflammable, couldn't it be used in the same way as acetylene or city

gas? As an illuminant, for instance.

These compression chambers could be built underground; perhaps the size of a city block and the depth of a 20-story building. A system similar to that used in the breech of a gun could be adapted to introduce the detonation charge to prevent backfiring from the compression chamber.

In countries where common sources of energy, such as water, coal, and oil, are scarce or not available except by importation, this use of dry explosives might be possible and practical. The power in dynamite, TNT, or an atomic bomb is power in highly concentrated and proportionately light form, and the shipment of these explosives over long distances does not offer serious difficulties. Therefore, when suitable compression chambers are developed here and made available in countries where power is scarce, we shall be able to export atomic power much more economically than we can send bulky shiploads of coal and gasoline abroad.—S. C. R., Portland, Ore.

He Suggests a Name for Atomic Power

MY GENERAL-SCIENCE teacher tells me that no name has yet been decided upon for the unit of atomic power. My suggestion is that it be called Atomic Thermal Unit, or, abbreviated, A.T.U. I believe that the calorie and the British thermal unit are too small to measure the thermal energy released by the disintegration of the atom.—D. A. S., Dayton, Ohio.

The Broom-Straw Test for Watermelons

IN YOUR November issue there is a letter from P. J. asking why a broom straw, placed horizontally across a watermelon, will turn to an angle of 45 degrees if the melon is ripe and remain still if the melon is green. There is an electrical charge or force in all growing things that produces the movement of the straw, but this charge grows less as death approaches, ceasing entirely at death. Ripeness in fruit is, of course, the state of death, even though decay has not set in.—Dr. J. H. D., Houston, Texas.

THE broom straw on the watermelon reminds me of the way Chinese test ivory in the market at Hong Kong. They take a broom straw or a small sliver of wood, place a drop of water on the ivory, and rest the straw in it. If it is real ivory, the straw swings in the direction of the grain. It never falls.—P. G. P., Van Nuys, Calif.

Schoolmaster Hands Us a Pretty Nosegay



P. S. M., Nov. '45, p. 20), and at the time I am writing this letter, I should be preparing for classes tomorrow in English, Latin, and French. It's not at all helpful, but keep it up.—W. H. E., St. Paul's School, Concord, N. H.

WHAT a magazine! As far as I can gather, your Readers Say department is 99 percent a collection of letters describing the amount of work their writers do NOT do when they receive your magazine. Men lose a complete night's sleep, housewives drop everything (Mrs. M. W. S.,

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Then you unroll the bags and give them a good boiling in a washboiler or other large utensil (not aluminum), using enough soap to make a good suds and adding two or three tablespoonfuls of soda to a half boiler of water. Punch and stir with a stick several times during the boiling. If all the printing does not come out, wring the bags, rub the remaining letters well with soap, and boil a second time in a fresh solution, adding baking soda as before. When the bags are free of printing, rinse them thoroughly and hang them out to dry.—Mrs. F. W. B., Corvallis, Ore.

Making a Hammer More Attractive Becomes an Easy Matter

ANSWERING the query by E. M. C., it is easy to remagnetize a hammer by simply winding a coil around the head and applying pure DC (not AC) to the coil. If the voltage is high, you put a resistor in series with the coil. A lamp bulb is an excellent resistor for this purpose. You can check the polarity of the magnetic field by means of a compass. No time is set for the process, but 15 minutes is about right for a hammer.—K. B. G., S/1c RT, USNR, Washington, D. C.



Reader Shares Secret of First Aid to Rusty Cars

I HAVE found that the use of valve-grinding compound on rusty bumpers and other badly corroded parts of an auto will clean them to a shining luster.—S 1/c C. W. M., Rochelle, Ill.

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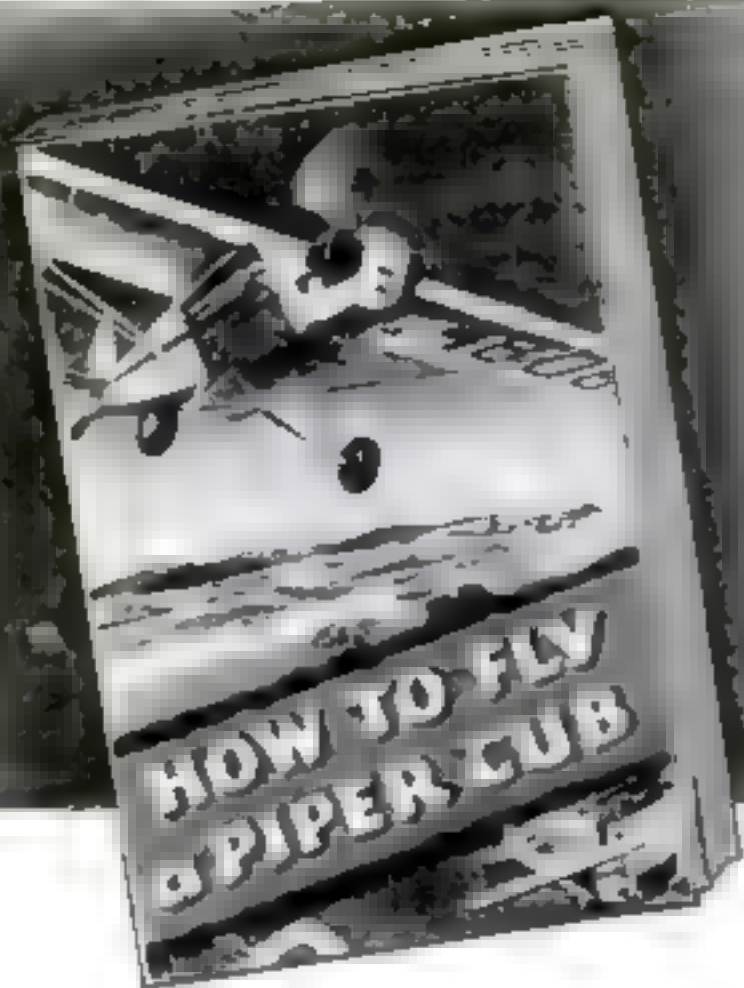
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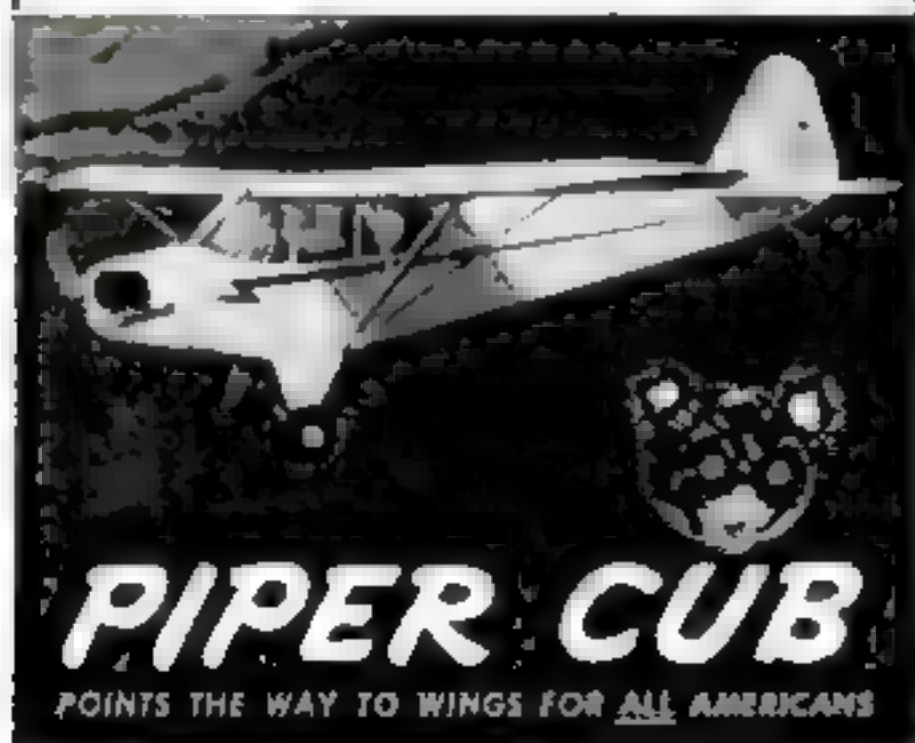
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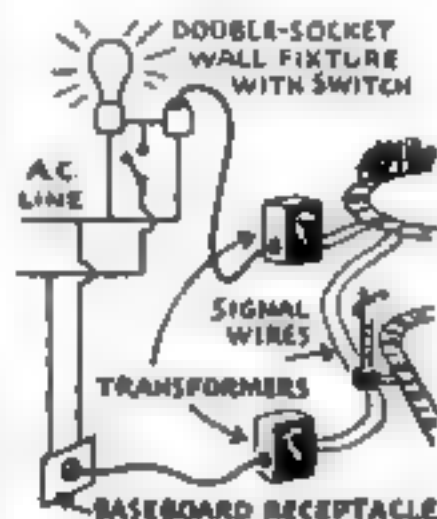
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Who Has a Recipe for Leaf Preservation?

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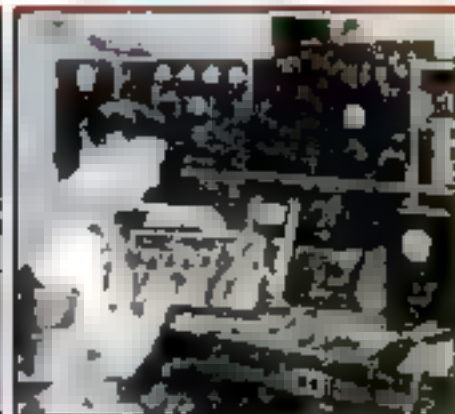
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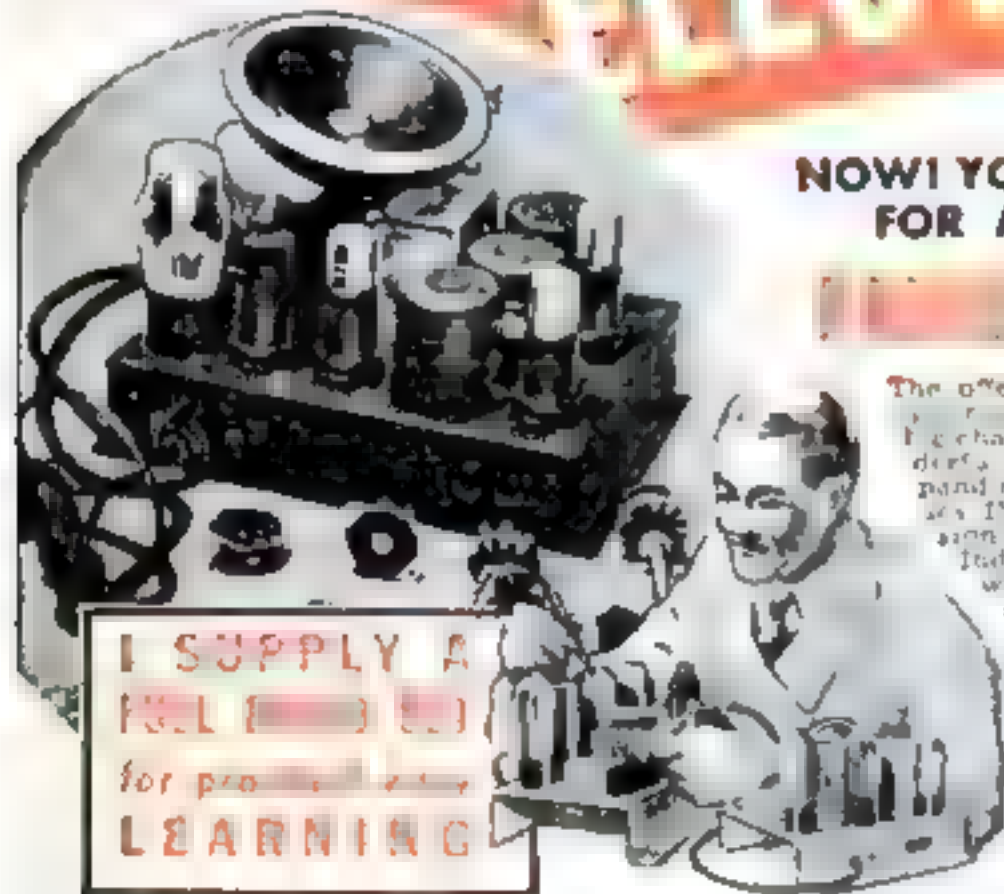


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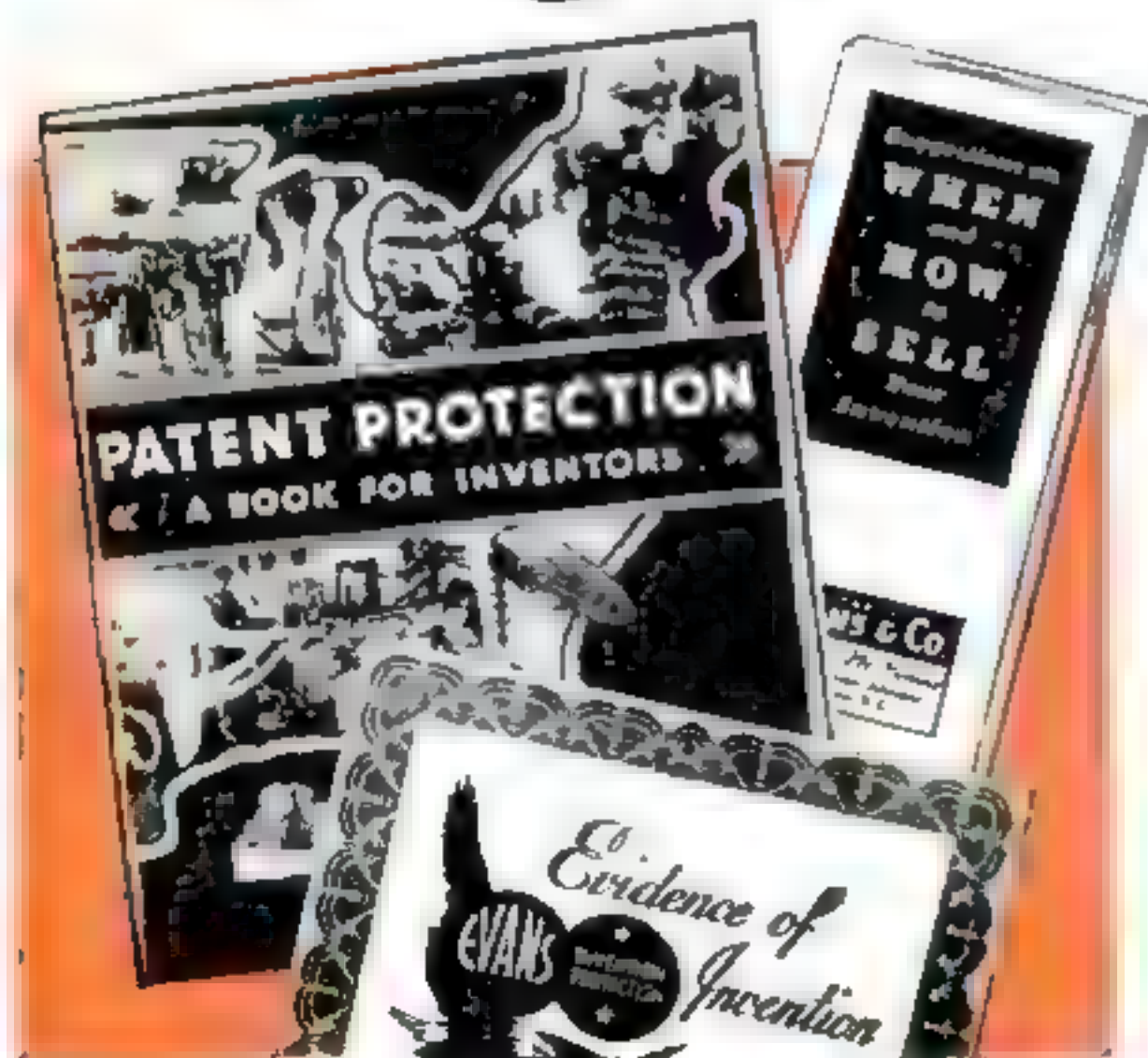
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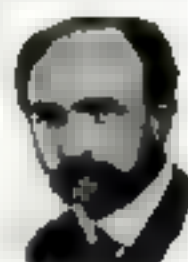
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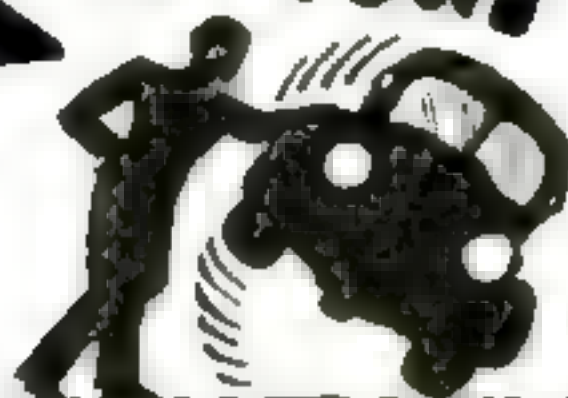
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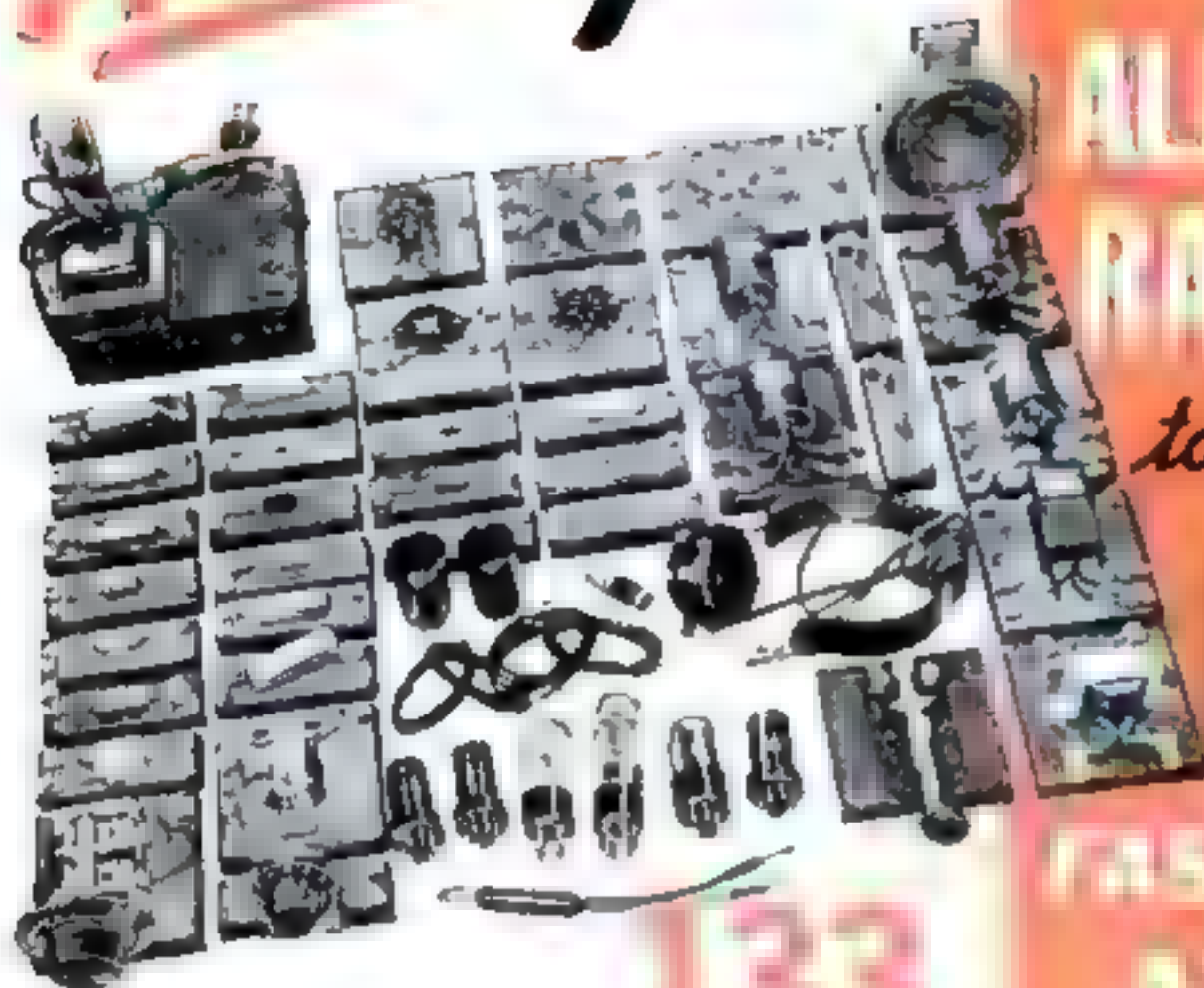
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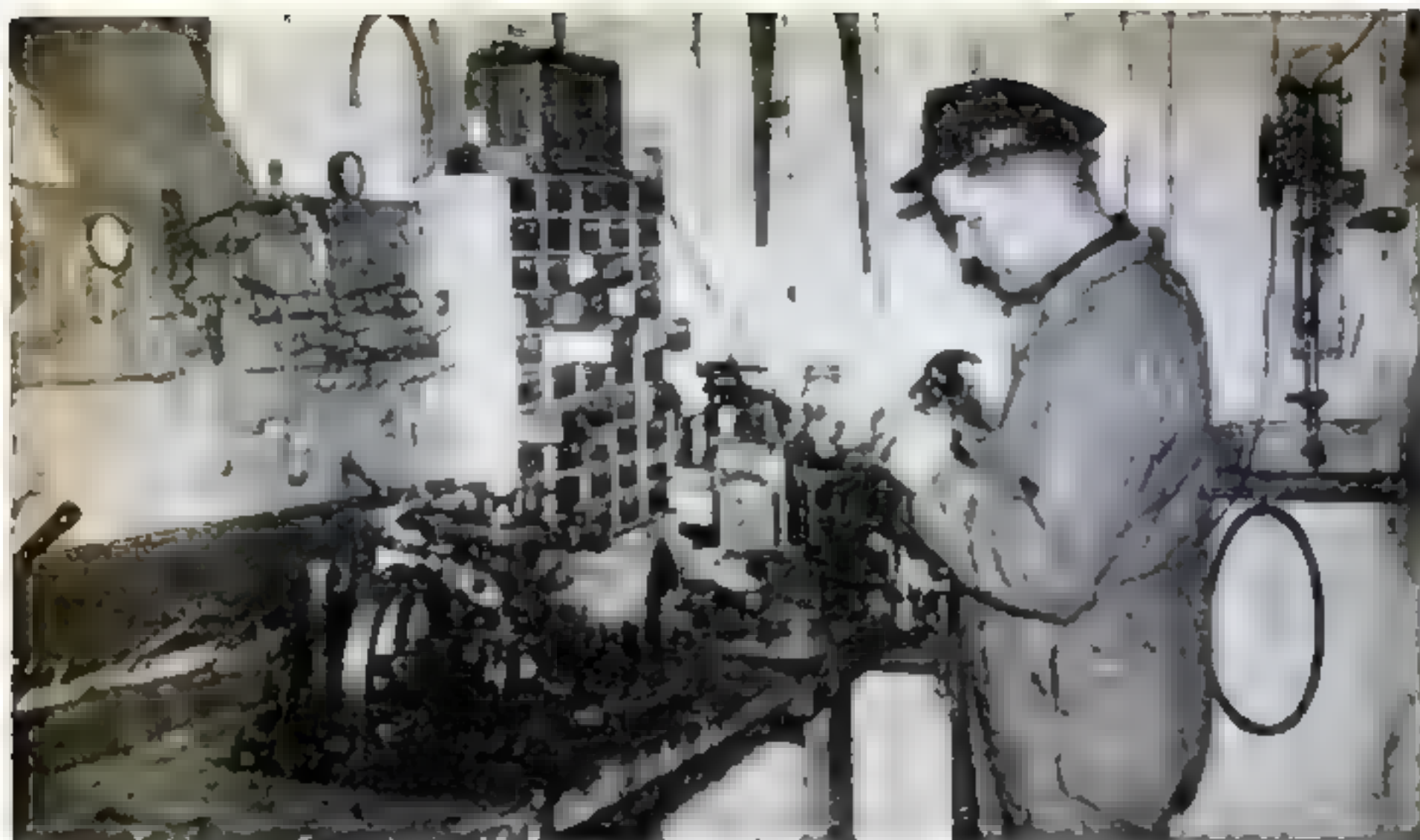
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Friends ask me about my future. And, I think I've got a grand one. Age is no handicap in repairing. I have in my files enthusiastic letters from repairmen ranging in age from 18 to 70 years. After the war, we're bound to see hundreds of new products on the market . . . products that the average person never dreamt of. These new products and our old appliances are all going to need at some time or other "fixing." Well, I'll still be the fellow to do it. The field open for appliance repairmen is unlimited. I don't worry at all about too much competition.

If You Are Ambitious

To the contrary, I've prepared a complete course, chuck full of simple, easy to understand photos and drawings and written in the same non-technical language as this article. I know the course is good, because I have hundreds of men all over the country writing to me telling me how the course has helped swell their pockets with cash. If you too want to prepare now for your future, I suggest you read the next page and send me the handy coupon."

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The Course in Appliance Servicing arrived a few days ago. Want to take out a few minutes of my valuable time to let you know that this is just what I have been looking for ever since I opened up my Fix-It shop. I must admit that you told the truth when you said that it contains quite a bit more information than I bargained for. P. J. Breit, Beiring, Ohio.

I am a mechanic for the Western Union Telegraph Co. Three days after receiving the lessons in refrigeration I earned the exact cost of the course. Henry S. Lee, Washington, D. C.

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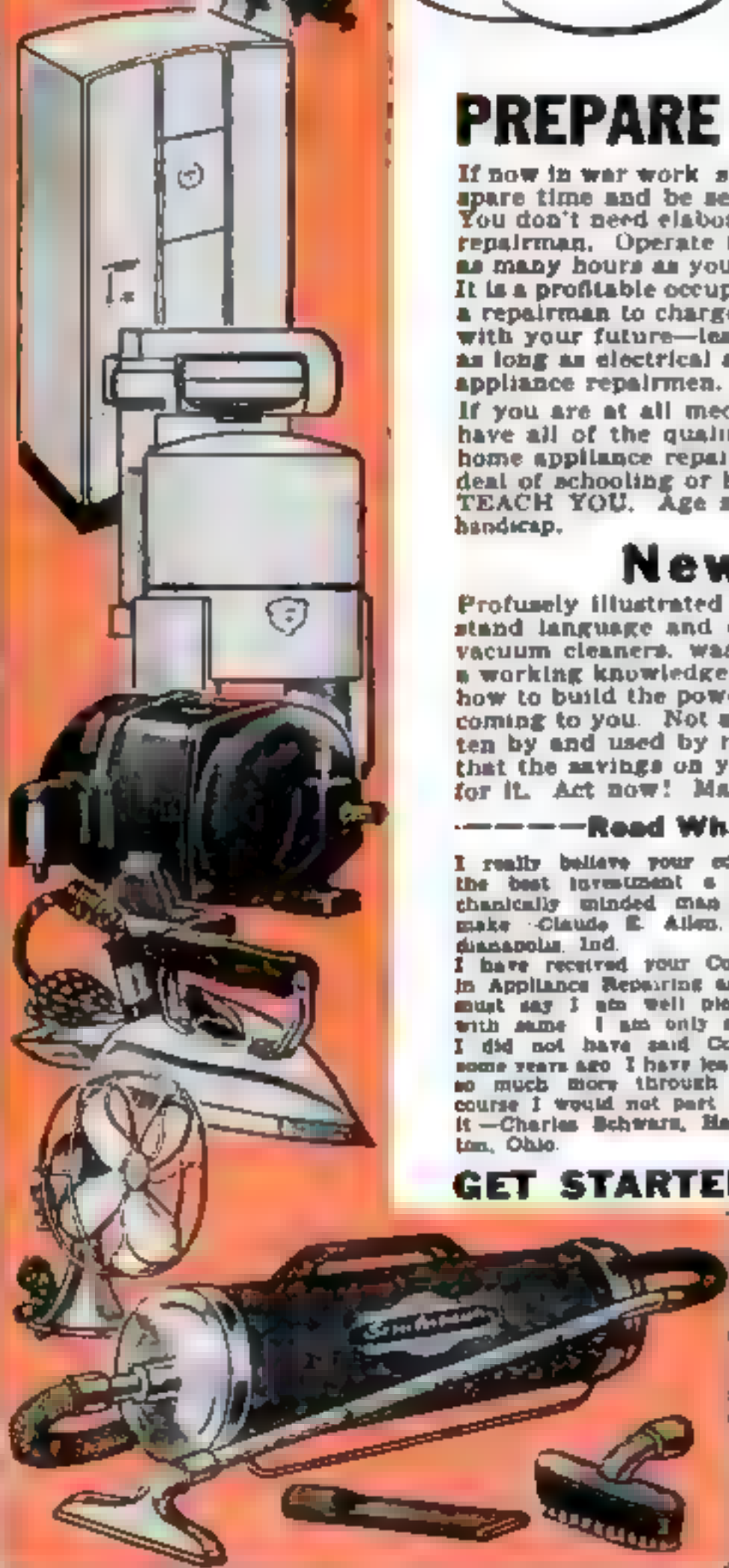
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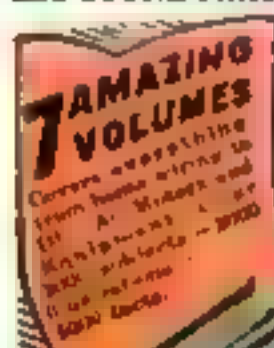
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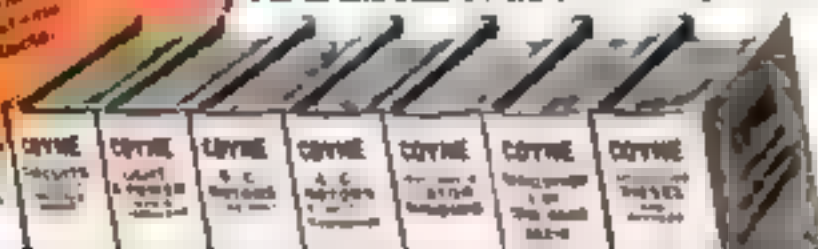
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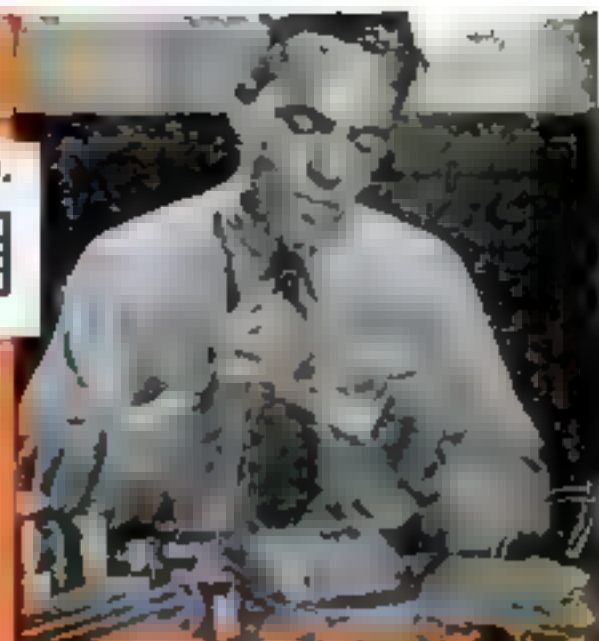
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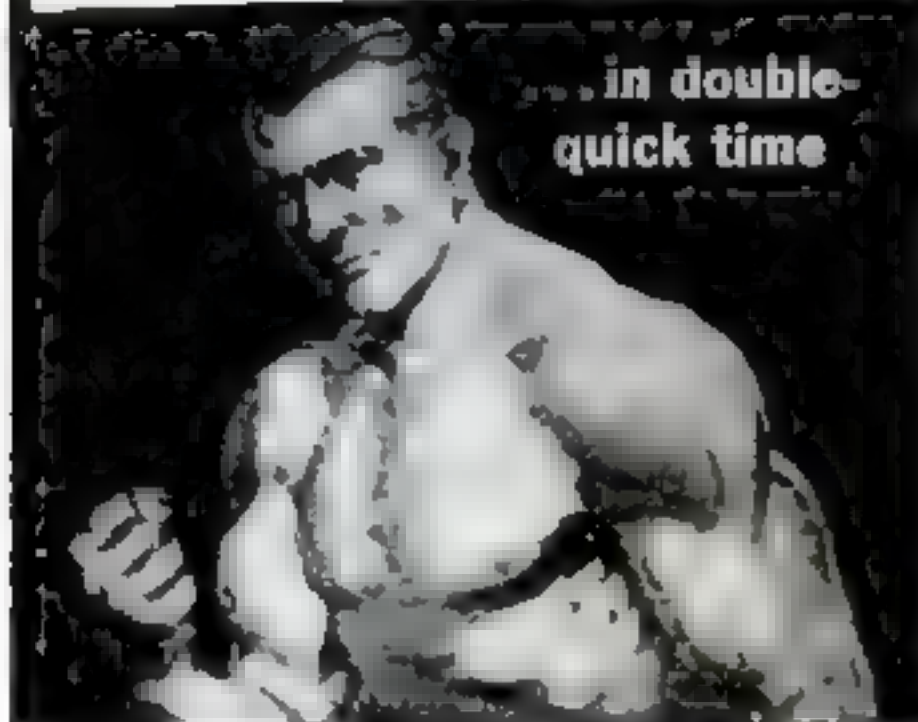
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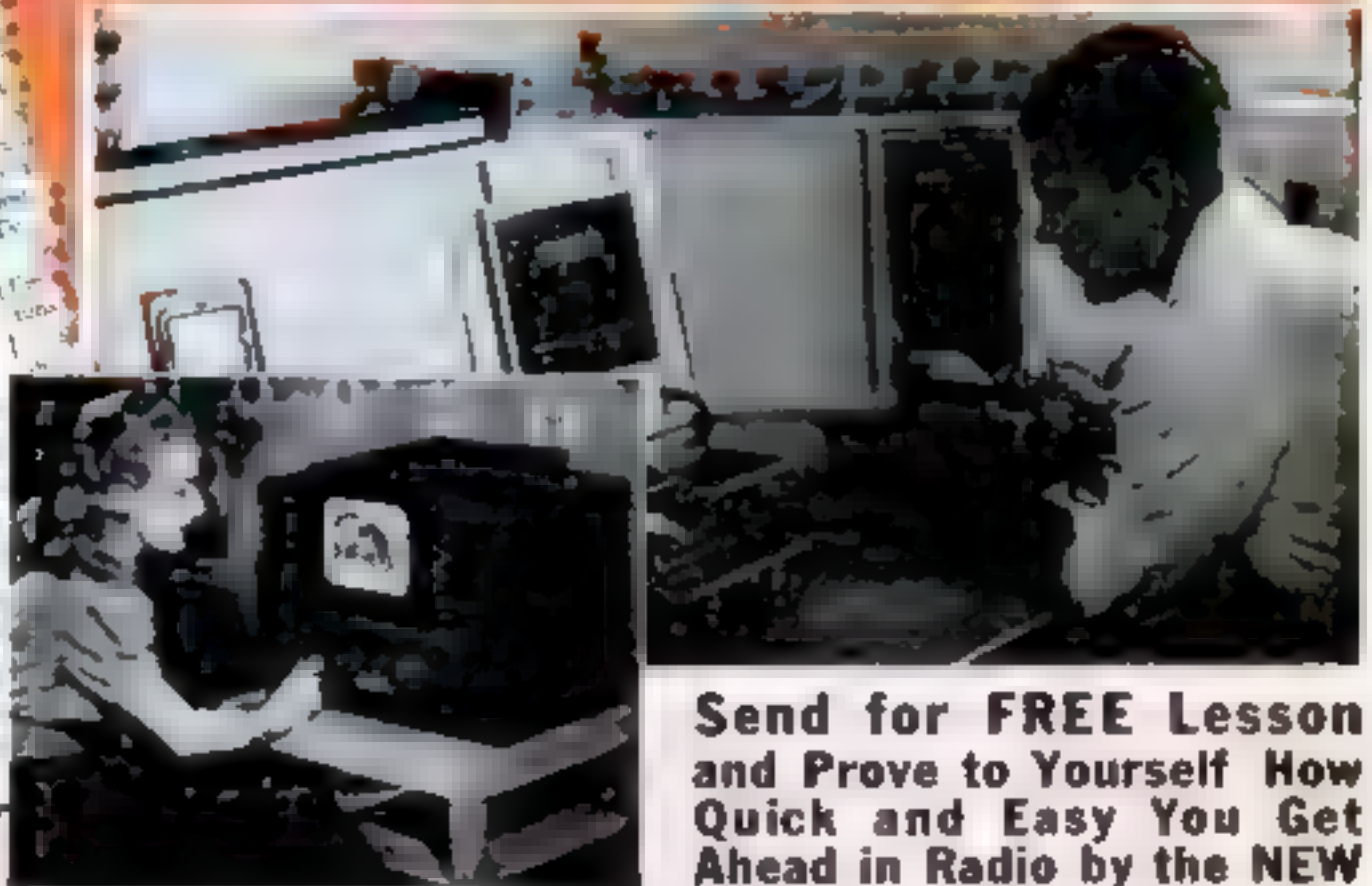
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Source: Industry Analysis Report, 2023



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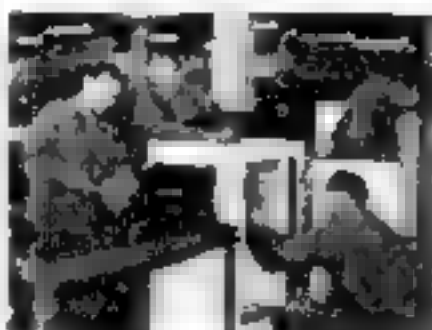
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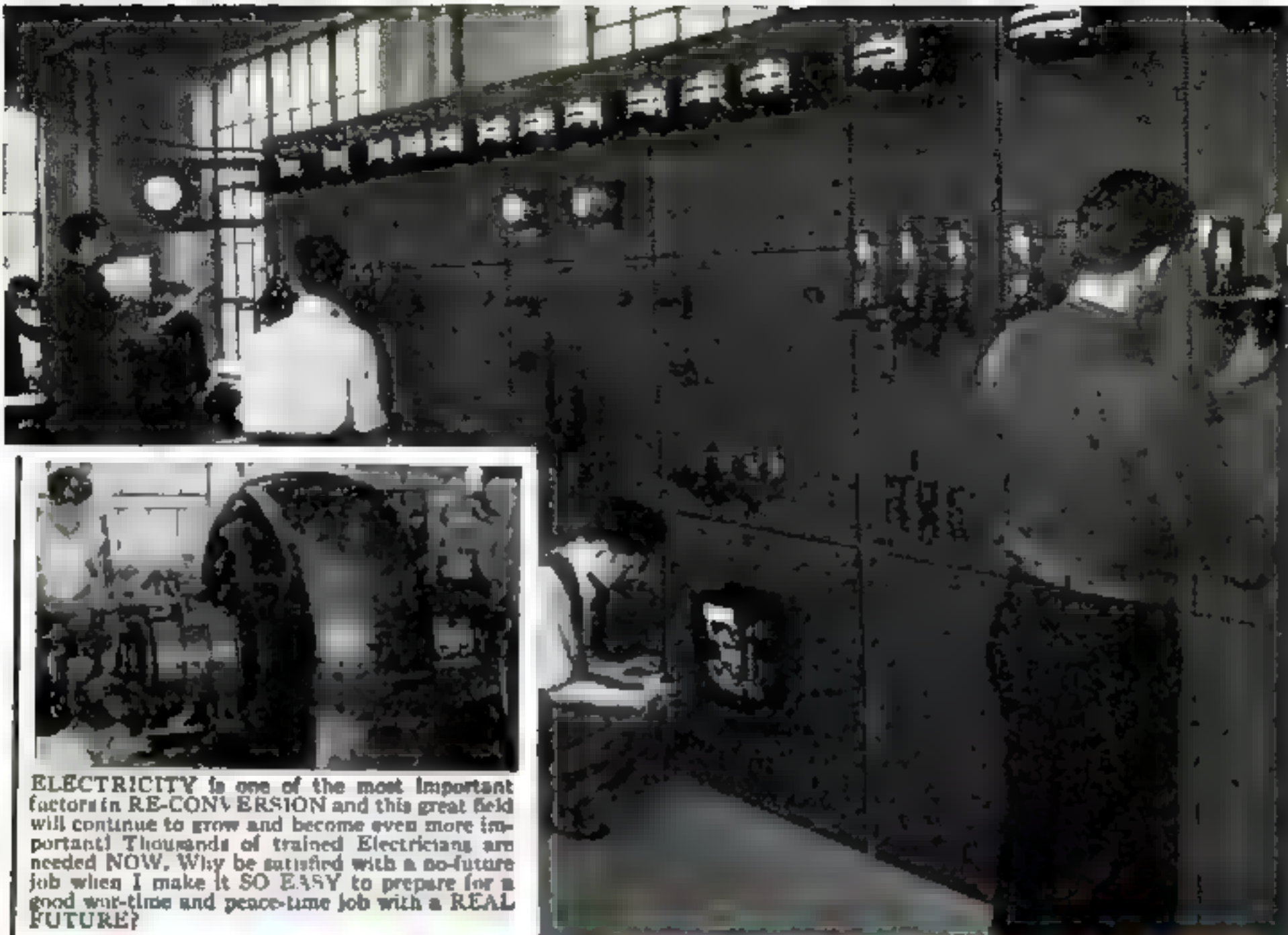
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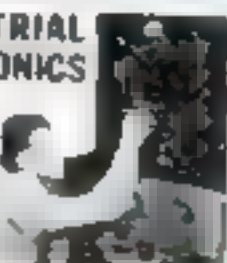
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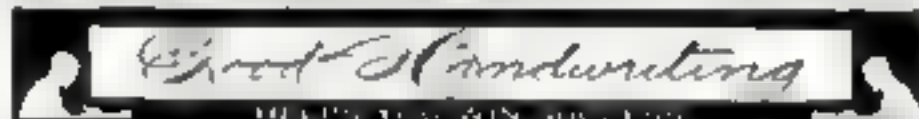


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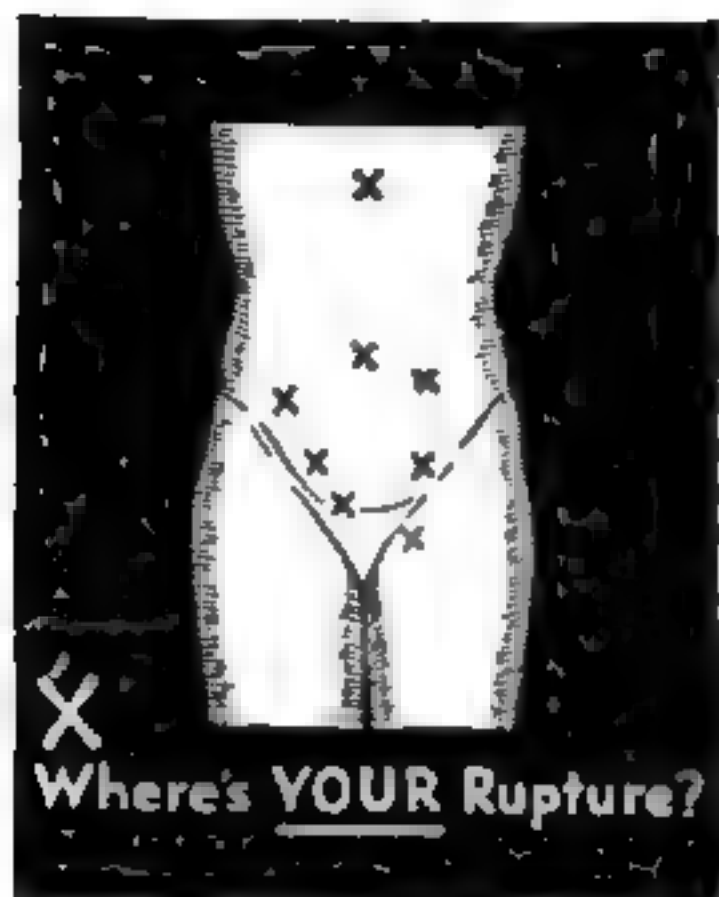
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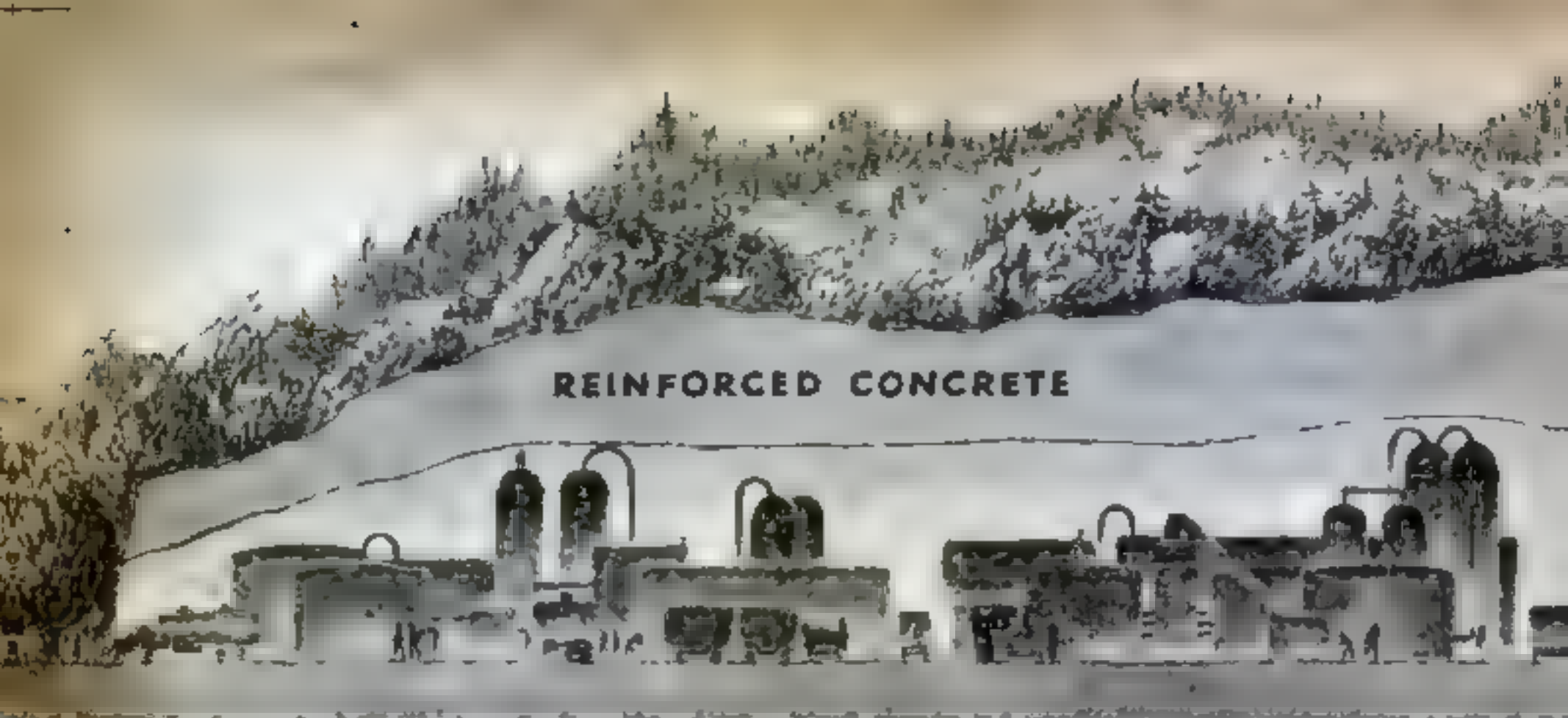
SO THE cyclotrons of Japan have been smashed. We can rest easier in our beds if not in our minds. We can evade, for another night, our fears—and our frightening responsibilities. But a sledge and a block of TNT are small solace and no final solution to either. For "thought police," in any uniform, cannot handcuff the human mind.

Such mere vaults of knowledge as the razed libraries of Alexandria and Louvain, or the burned books of Berlin, may be destroyed again. But science as truth, science as the human thrust from the unknown dark into the light of knowledge, cannot be destroyed unless man himself is destroyed. Ultimately, science is something more than "an orderly approach to a problem." Science is that human hunger to *know* which distinguishes thinking man

from the blind beast and the savage retreating to the cave of his own fears.

The protests of aroused scientists could not stop the destruction in Japan. But there must be no more sledge-hammer thinking in America. To destroy a cyclotron, or an electron microscope, or a rack of germ cultures—in any country—is to destroy the tools of science. It is to put out men's eyes, maim their groping hands. Certainly, the world needs more, not less, scientific thinking. But even the greatest scientific ideas are impotent until implemented and proved and projected with the machines of science.

The scientists, who have freed men from the shackles of space and time and matter, can lead man to that knowledge of himself which he needs to live in dignity—and to survive.—PERRY GITHENS.



REINFORCED CONCRETE

Underground lubricating plants were being built in Germany when it fell, but they were begun too late.

RISE AND FALL OF

Why Air Blows That Smashed Synthetic Oil Industry

By VOLTA TORREY

"The German experience suggests that even a first-class military power . . . cannot live long under full-scale and free exploitation of air weapons over the heart of its territory."—Report of United States Strategic Bombing Survey.

NAZI Germany was a chemical empire that rose swiftly, fell suddenly. Its history has been written now by scientists. Civilian chemists and engineers of the U. S. Strategic Bombing Survey have unraveled

this unprecedented empire's inside story from secret German records, interviews with German authorities, and extensive surveys of the bombed-out plants and laboratories of the Reich's oil, chemical, rubber, and explosives industries.

These industries were the basis of Hitler's power. They produced the fuel for his warplanes, U-boats, tanks, and V weapons. They supplied substitutes for the hundreds of natural products which the British blockade kept him from obtaining elsewhere. By producing innumerable items, mainly from coal, air, and water, these industries enabled

Germans hid small distillation units in the woods, like Kentucky moonshiners' stills, to elude bombers.





REINFORCED CONCRETE

Nazis planned to produce 92,000 tons of aviation fuel, quantities of other products, deep in the earth

A CHEMICAL EMPIRE

Caused Mighty Nazi War Machine to Grind to a Halt

the Nazis to blitz and defy much richer nations.

Unlike America, Germany had very little natural petroleum. When Hitler invaded Poland in 1939, he had on hand only enough aviation gasoline to fight for about three months, and only enough automotive gasoline and nitrogen for explosives to last about two months. New fields discovered near Vienna during the war yielded more crude oil, and additional supplies and refineries were stolen from other countries. Even so, more than four-fifths of the Nazis' gasoline, 99 percent of their rubber, and all of the nitric acid used in their explosives came from Germany's plentiful supplies of coal.

Friedrich Bergius, a Nobel Prize winner, found a way in 1920 to make liquid oil molecules by splitting the complex molecules of coal and forcing hydrogen into them. Since the hydrogen had to be used under pressures up to 10,000 pounds per square inch and at high temperatures, building the compressors used in Bergius plants was a task comparable to manufacturing naval guns. Fifteen times as much steel was required for synthetic oil plants as for ordinary refineries, and the Germans devoted as much steel to the construction of such plants between 1937 and 1944 as would have been needed to build a battle fleet four times the size of the U. S. Navy in 1940.

Another prewar development, the Fischer-Tropsch process, enabled the Germans to take molecules of carbon monoxide and hy-

drogen from coal and build up various oil molecules. The products obtained by this synthesis had special properties, for which many chemical uses were found. But the more complicated Bergius method was used more extensively, because it was the only one by which great quantities of aviation gasoline could be produced.

Both processes were expensive; gasoline produced synthetically cost from four to five times as much as gasoline obtained from crude oil. The coal needed to make enough gasoline to fill the wing tanks of a Flying Fortress would heat an average-sized home in New York all winter, and an average-sized German synthetic oil plant consumed more electricity than an American city of 250,000.

Regardless of the cost, the Nazis set out long before the war to make themselves independent of other nations. Powder and explosives plants, which had been trimmed down to reasonable proportions by the Treaty of Versailles, were expanded with the help of a state-owned corporation created secretly in 1932. Synthetic rubber production was increased nearly 2000 percent in three years. And the production of synthetic liquid fuels was encouraged by slapping a tariff of 30 cents a gallon on gasoline in 1937, and by lending money and guaranteeing prices to the chemical and coal concerns.

Germany's well-developed chemical industry, with 12,000 qualified chemists on its payrolls in 1937, had grown up in the Ruhr,

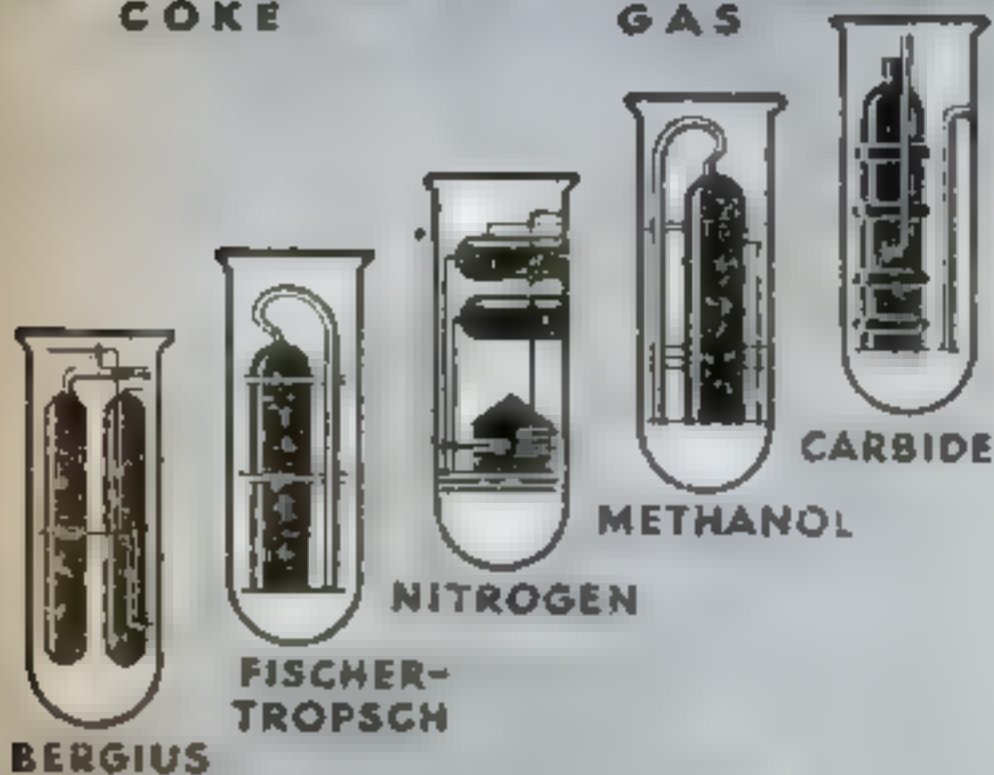


COAL



COKE

GAS



BERGIUS

FISCHER-TROPSCH

NITROGEN

METHANOL

CARBIDE



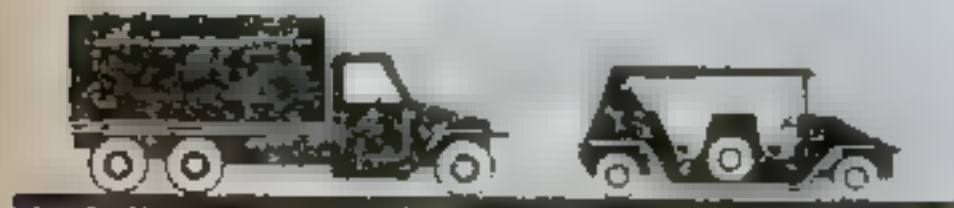
AVIATION GASOLINE



MUNITIONS



DIESEL FUEL



AUTOMOTIVE GASOLINE

RUBBER TIRES



along the Rhine and in Central Germany, in or adjacent to the coal fields. The I. G. Farbenindustrie held the patent rights to the Bergius process and Ruhrchemie had the rights to the Fischer-Tropsch process. The plants of these and other firms were expanded, and new plants were erected in the same areas. Thus, the oil, chemical, rubber, explosives, and other industries of the Reich were interlocked not only by their mutual dependence on coal but also historically, geographically, and mechanically.

The gigantic chemical empire that rose under Hitler's regime is described, in fact, as an "octopus" in the official report of the Oil Division of the Strategic Bombing Survey. Its body was the gas-generating plants, and its arms were the many plants that used those gases to produce a long list of chemical products.

This octopus continued to grow, despite many small aerial attacks, until the spring of 1944, when it became the target of an intensive, strategic bombing campaign by both the RAF and the 8th Air Force. It was well defended. Huge, reinforced concrete "dog houses," and brick blast walls shielded the vital parts of the plants; and bombardiers often were deceived by decoy plants—which had wooden partitions built to simulate the appearance of oil tanks, and fireworks that could be set off to make observers think that real plants were being destroyed.

The bombs used against the synthetic oil targets in the first big strategic attacks were too small. People were killed, pipe-bridges, utility lines, and sewers were damaged, and operations were halted, but the plants recuperated quickly. The first aerial attacks, in other words, merely damaged some of the arms of the octopus. But later, as bigger bombs were developed and hurled against these targets, the gas-producing facilities which were the heart of the whole group of industries were hit and shattered.

Nazi authorities saw what was coming a year before the war ended. The Plans Division of the German Air Force reported in 1944 that "the greatest danger lies in the threat to the fuel supply," and Albert Speer, Reichminister for Armaments and War Production, confidentially warned Hitler that "if the attacks on the chemical industries continue, those very materials essential for continuation of modern warfare will be unavailable in the most important fields."

Edmund Geilenberg, a former miner who had worked his way up to be manager of

Most of Germany's aviation and car fuels, all its nitric acid, vast stores of chemical materials for rubber, other vital products, were synthesized from coal.

the Brunswick Steel Works, was made General Commissioner for Immediate Measures. These measures included the swift, energetic repairing of bombed-out plants and steps to disperse oil production facilities and move plants underground. Geilenberg was told by Hitler to tackle the work "with a generous supply of manpower and material and reckless energy."

Exactly one year after he was given almost unlimited authority, American occupation forces found Geilenberg repairing bicycles. At one time, however, he had commanded a labor force of 350,000 persons, and the speed with which his crews repaired the damaged plants made it necessary for the airmen to attack oil targets time and time again.

The most grandiose of the Nazi plans to save their chemical industries were those which called for hiding small plants in the woods throughout Germany, where they would be as invisible from the air as the stills of Kentucky moonshiners, and moving enough additional plants underground to keep the Luftwaffe in the air.

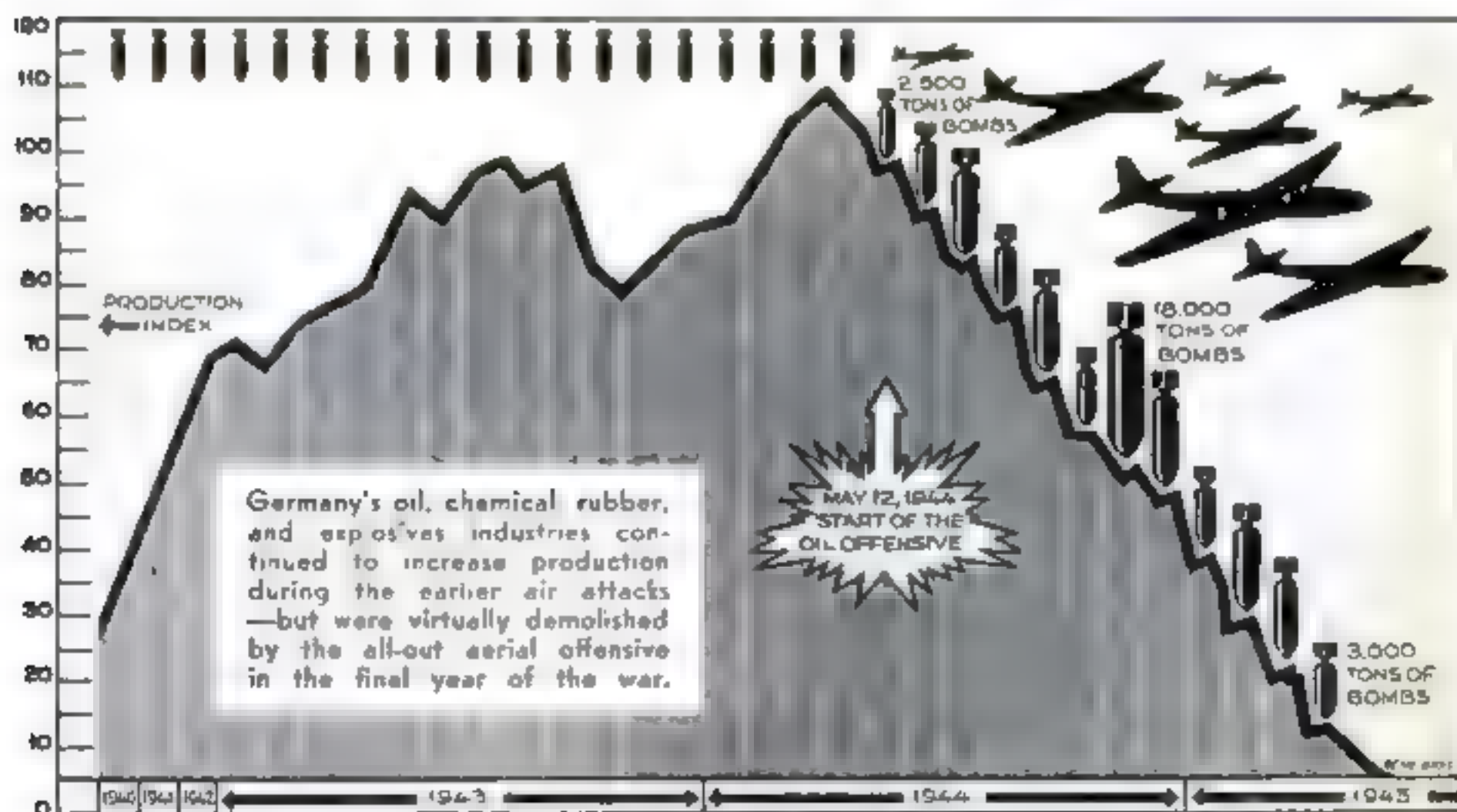
In the opinion of the Strategic Bombing Survey's experts, the idea of moving fuel production underground was feasible. Properly designed and ventilated oil plants could be operated underground with reasonable safety. But the Germans' underground and dispersal program was never completed. It would have required a full year's labor by at least 200,000 men, more than were employed in the whole oil-refining industry of the United States in 1944, and the Americans and Russians closed in on the Nazis

too fast for them to prolong the war this way.

Even if they had succeeded in moving colossal plants underground, the destruction of railroads and sources of power on the surface would have made the plants of little value. Lack of storage space would have kept them from running at full capacity without adequate, regular, transportation service. With no more steel than was used to repair damaged surface plants, however, the Germans could have run pipelines to refineries from oil fields and extended a network of distribution pipes throughout Germany. They might then have been able to supply their armed forces with a respectable quantity of oil products despite the strategic bombing.

Instead, aviation gasoline became so scarce that the Luftwaffe had to stop training pilots in September 1944. Men with only 40 to 45 hours of flight training were sent into combat, countless planes were lost because of the pilots' inexperience, and hundreds of planes were grounded.

Automotive gasoline became so scarce that the speed limit was set at 17 miles an hour and every trip of more than 60 miles had to be approved by a commanding general. Although 1,200 German tanks were massed against the Russians at the Baranow bridgehead in 1945, the Germans had only enough fuel to refill the tanks two or three times. On other occasions, tanks and armored vehicles were moved to the front by oxen. Gas generators which made it possible to use coal or wood as fuel were put on 100,000 vehicles a year before the war ended and *(Continued on page 810)*





The Deaf Can "Hear" by "Reading" Pictures of Sound

SPOKEN words are turned into readable patterns for the deaf on a machine developed at the Bell Telephone Laboratories. Spoken into a microphone, words are electrically translated into strange patterns on a screen that flashes by, much as are the news bulletins on an electric sign. Sound has three dimensions—pitch, loudness, and time—all of which affect the patterns moving slowly across the screen. The trained eye reads them as speech. Dialects are shown as such; the device is not stumped even when

the word "curve" is uttered as "colve."

The apparatus also enables a deaf person to improve his enunciation, which, because he cannot hear the finer shadings in his own voice, usually is a dull monotone. If his pronunciation of a word does not flash a pattern that compares with one recorded by a voice teacher, he may correct his delivery until he is able to adjust it to a normal speaking voice. Then, after a little practice he is able to add emotional color to his speech.



Courage and an artificial arm enable Master Sgt. Hensel to shave himself, while his wife stands by.

Armless Soldier Shaves with Electric Razor

MINUS arms and legs, Master Sgt. Frederic Hensel, veteran of Okinawa, shaves handily with the aid of the artificial arms and hooks with which he has been equipped. Sergeant Hensel's legs and left arm were blown off when he stepped on a Japanese land mine last June, and, shortly after that, his badly mangled right arm was amputated.

With the aid of new devices, maimed fighting men are now able to do many things for themselves with almost natural movements. A steel aircraft cable in a flexible housing enables the armless man to use a pen or pencil, handle a cigaret, manipulate a knife and fork, knot a necktie, or, as shown to the left, shave himself.



"RAWIN" SPIES ON THE WEATHER

**New radiosonde
apparatus aided
wartime flying**

BALLOON "scouts" in the stratosphere helped keep U. S. Army and Navy planes flying during the war in all but the foulest weather conditions. One reason why missions were accomplished in anything less than a typhoon or a black fog was that service meteorologists knew more about the weather than ever before. For the past three years they have been aided in their remarkable long-range, long-distance forecasts by a "weather sleuth" that gathered clues on winds, temperatures, and pressures from the upper atmosphere and solved the mystery of what was going to happen climatically.

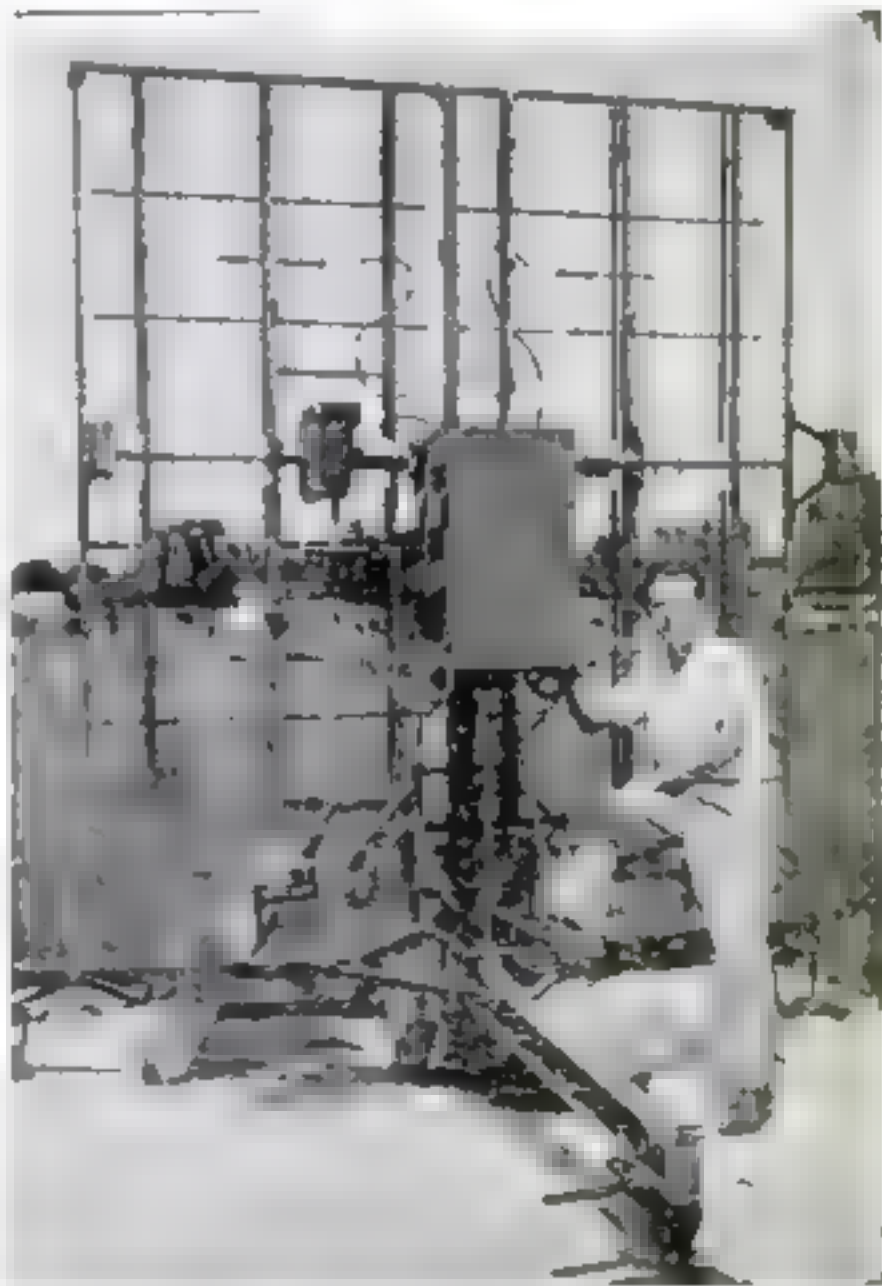
This wartime refinement of the well-known radiosonde, like its ancestor apparatus (P.S.M., Nov. '43, p. 90), consists of a balloon-borne radio transmitter and a recorder unit. Its technical name is SCR-658, and it was developed by the Army Signal Corps and engineers of the Farnsworth Television & Radio Corporation.

SCR-658 makes possible more accurate observation and tracking of the high-flying balloon unit, in this case called the Rawin (Radio Wind) detector. The apparatus includes a radarlike direction finder on the ground that "sees" the detector and follows its upward course accurately through fog, clouds, and darkness.

The Rawin detector's $3\frac{1}{2}$ -pound, battery-operated, AM-FM radio transmits signals at 397 megacycles as it climbs and as it gently descends, by paper parachute, after the hydrogen-filled balloon has burst in the thin air of altitudes over 60,000 feet. The

signals are picked up by the SCR-658's direction finder. Its operator adjusts the antenna with hand-wheel controls to keep the drifting, rising balloon centered in his cathode-ray scope. He can read at a glance the correct azimuth and elevation indications. A recorder, frequently situated in the weather office, as much as 500 feet away, is connected to the direction finder's receiver. It "decodes" the AM and FM radio signals and traces patterns on a graph that indicate the changing air temperature, humidity, and height of the balloon. Since altitude is expressed in terms of barometric pressure, the observers can readily obtain any pressure data they need.

Weather Bureau officials are said to be considering the operation of SCR-658 equipment in U. S., as an aid to commercial aviation, maritime industries, and to farmers.



DIRECTION FINDER "sees" balloon climb into stratosphere; it has a radarlike scope in box unit.



Pulling another mine's teeth—10,000 such menaces have been accounted for by fleet of 600 U. S. sweepers.

THEIR WAR IS NOT OVER

U. S. Navy's sturdy little minesweepers doggedly fight on in hard Pacific campaign against both Jap mines and ours.

By DEVON FRANCIS

Photographs by U. S. NAVY

FOR some men in the U. S. Navy, V-J Day was just another date on the calendar. Their war will go on for another two years, maybe longer, because they are assigned to sweeping murky ocean water clear of mines.

During six years of war, tens of thousands of explosive containers were sown in the waters of the Seven Seas, by both the Axis and the United Nations, to tear open the hulls of enemy ships and send them to the bottom. To make peacetime commerce safe, these "fields" of mines must be decontaminated. The western Atlantic is cleared and the British and Russians are clearing the eastern Atlantic. Fortunately, our Navy has only the Pacific's waters to worry about—but the Pacific is the world's biggest ocean.

Sweeping mines is a hard, dangerous job. It is like feeling for a needle in a haystack. Even with the help of meticulous reports from the Japanese as to where they sowed mines, a flotilla of sweepers is never sure when a prow will crush the soft "horn" of a contact mine, or trigger the sinister mechanism of a magnetic mine, setting off hundreds of pounds of explosive.

One out of every five vessels engaged in minesweeping during the war was sunk or seriously damaged. Some were struck by shore fire—the minesweepers always paced the assault in an amphibious operation—and some went down under air attack.

Holiday Cargo, Crew Safe As Ship Hits Japanese Mine

By The Associated Press.

PEARL HARBOR, Nov. 17.—The U. S. S. Bridge, carrying 102,000 pounds of Christmas and Thanksgiving turkey to Navy personnel in Korea and China, struck a Japanese mine off Japan and was disabled, the Navy announced today.

The crew and the cargo were transferred safely to the U. S. S. Marin. The Bridge was pumped out and towed to an unannounced port.

Mines, however, continued to sink sweepers after the battles ended, and without differentiating between friends and enemies.

A mine is as deceptive as Baby Face Nelson. It is easy to sow, but pulling its teeth is something else again. When German submarines were attacking convoys off Key West, Fla., in 1942, the U. S. laid 3,460 defensive mines at that rendezvous point for shipping, but only 1,663 were found in 1944 when the field was ordered decontaminated. Four of those missing mines had sunk four Allied ships. Others undoubtedly had gone off unobserved and some had sunk into the mud of the ocean floor to become so en-

crusted with barnacles that nothing would set them off. Mines are so hard to find and detonate, once laid, that the United States turned down a project for sowing a "barrier" mine field 100 miles at sea off the entire Atlantic coast, even when German submarines were picking off our ships like sitting ducks.

In World War I the famous North Sea mine barrage, numbering more than 70,000, bottled up the entire German navy, submarines included. In World War II a barrier of mines from Iceland to the Norwegian coast threw such fear into U-boat skippers that, the story goes, they broke out a bottle of champagne whenever they managed to nose through it safely.

Minesweeping is dirty with danger because sweepers never know what these outsize booby traps are going to do next, or how they can outguess them. Mine warfare is a day-to-day battle of cunning and inventiveness between the men who design mines and those who try to keep them harmless.

The Germans led in mine designing throughout most of World War II. They introduced the magnetic mine, set off by the magnetic field of a metal ship. No sooner had the Allies whipped this weapon by "degaussing" their ships—decreasing their magnetic fields—and by exploding such mines with wooden sweepers trailing "tails" of magnetic cable, than the Germans put out an acoustic mine. Mere noise would set it off, and ships make a lot of underwater noise. Warships, cargo ships, and sweepers met this challenge by reducing speed and projecting a bedlam of noise in front of them. For a time, ordinary air hammers beating on steel plate served the purpose.

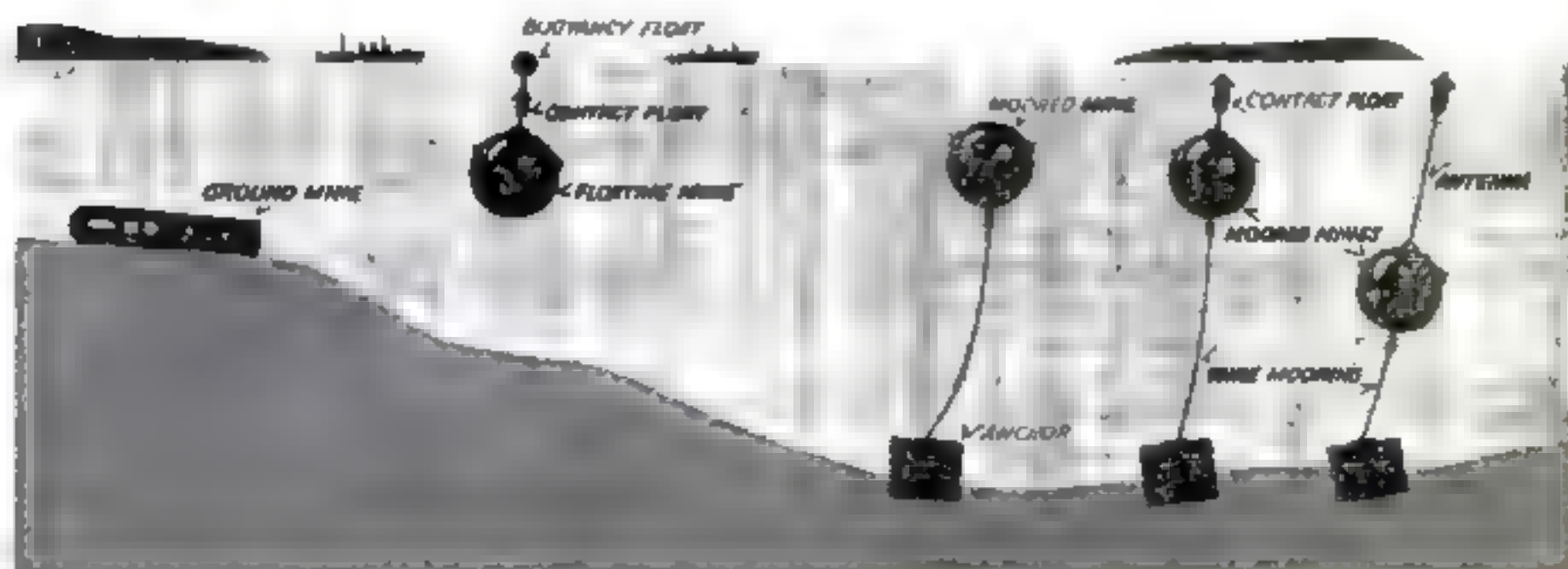
The Germans then wedded the acoustic mine to the magnetic mine. Sound prepared the mine to go off, but only after sound had removed the safety catch would the mine



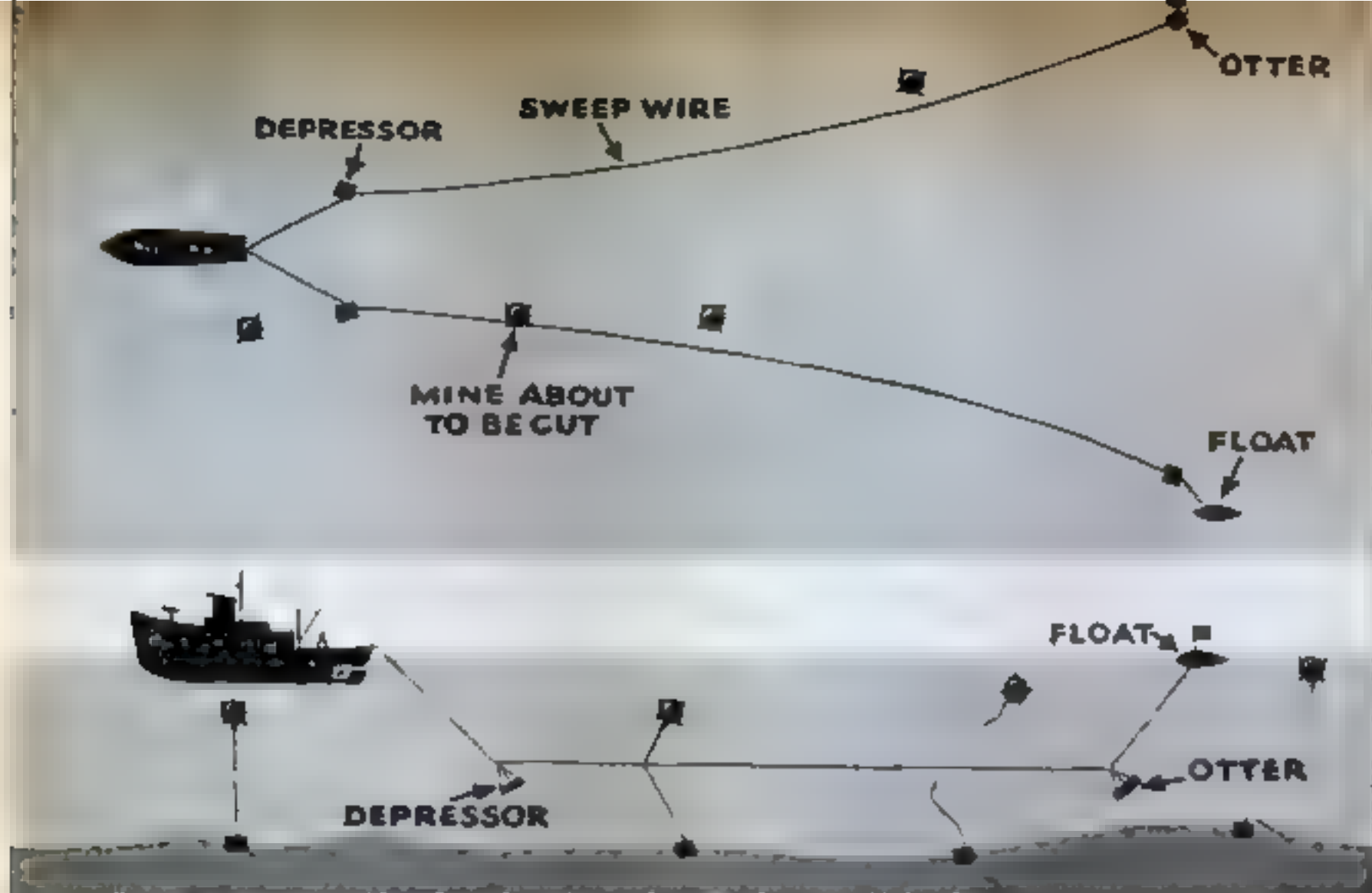
"Tail" of sweeper hunting magnetic mines has two electrodes, making closed circuit, to set them off.

detonate from magnetic influence. A shallow, light sweeper not fitted with a noise-maker could sweep all day and yet not clear a passage for heavy, noisy vessels. If the Germans later reversed the order in which sound and magnetism affected the mines, the "tail" of a magnetic sweeper could pass over them harmlessly. The mines were still there, ready to explode.

Another German trick was the "ship



Mines are of three types: ground, floating, and moored. Most moored mines are fired by contact; ground mines usually are acoustic, magnetic, or both. Floating mines, menace to friend and enemy, are rarely used.



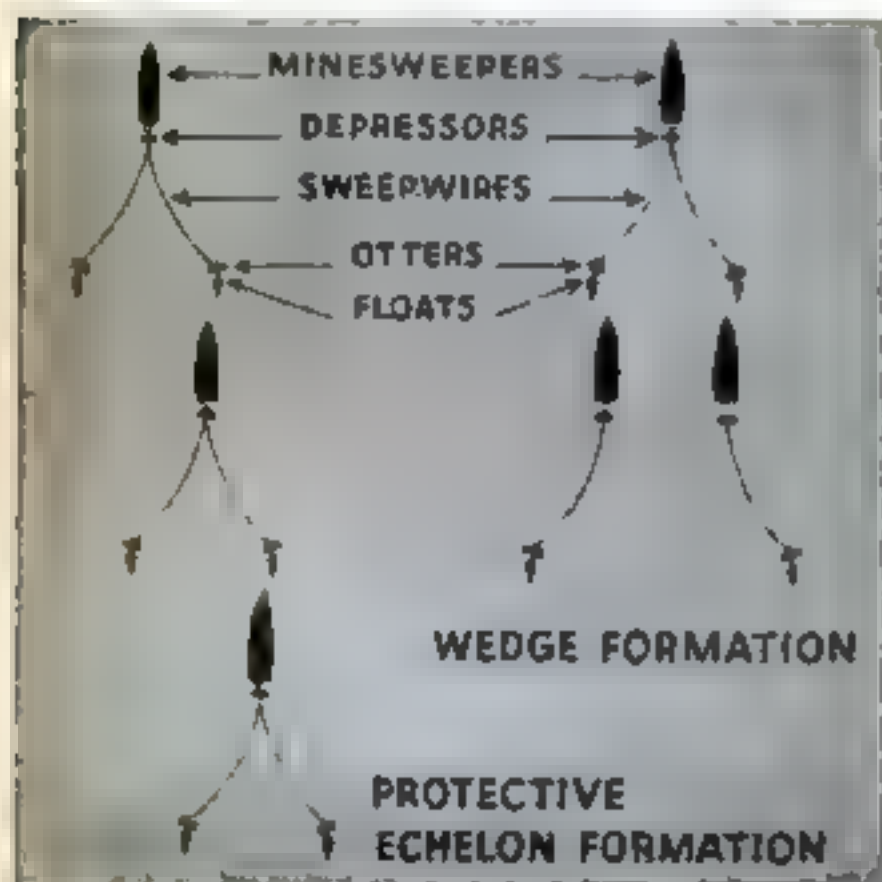
From the rough-edged sweep wire hang a "depressor," astern of the ship, and "otter." The "otter" rides below floating "pig" at wire's end. If wire doesn't cut mine's anchor line, "otter's" knife usually does.

counter." Magnetic mines fitted with counters did not detonate until a given number of ships had passed over them. Sweepers had an endless job dragging their "tails" over suspected mine fields until a "counter" went off. The Germans used this technique in an effort to catch capital ships, normally preceded in formation by sweepers, destroyers, and cruisers. "Counters" occasionally threw convoys into turmoil by sinking or damaging ships in their midst.

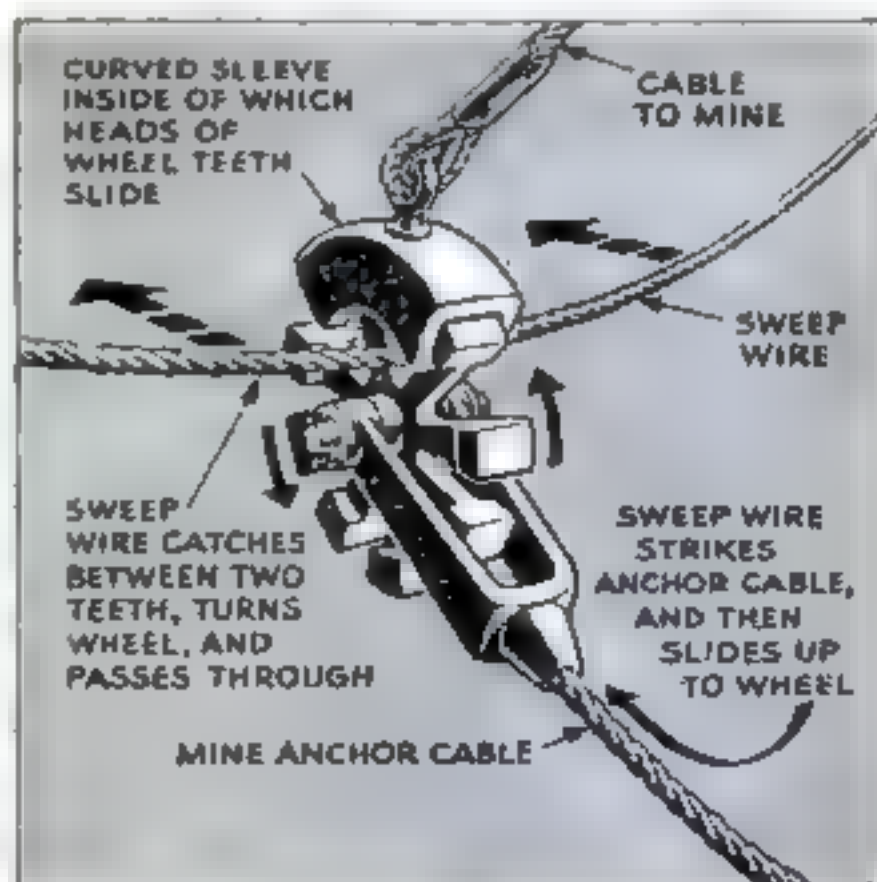
"Sweep obstructors" of various types also

complicated the job of the Allied sweepers. Some were buoyant cases containing enough explosive to part a sweep wire; others had cutters. Some were heavy chains, supported by buoys, that would break the sweep wire. The Germans actually had a mooring cable designed to let a sweep wire pass right through it, but it didn't work well.

They outsmarted themselves, too, when they put 80-day clocks into mines planted off British harbors. The clocks were set to sterilize the mines after a certain date.



A leading sweeper is not a good risk, but those that follow, in such formations as these, are protected.



Germans thought this sprocket would pass sweep wires through their mine cables, but barnacles fouled it.



YMS, in naval nomenclature, labels this small, typical minesweeper as a craft 136 feet long, of 300 tons displacement. DMS identifies a much bigger sweeper, a converted destroyer of 314 feet and 1,190 tons.

When some of those mines broke loose and were washed ashore, the British experts found out when Hitler planned to attack England.

The U. S., fighting a hard war in the Pacific, began its mining operations slowly, but made up for lost time. At Brunel Bay, Borneo, we trapped a big Jap fleet unit by mining its escape route, and the next day bombers hammered the vessels unmercifully. At Surabaya, our mines cut 200,000 tons of Jap shipping a month to a trickle. We "mined in" 32 ships at a Palau harbor and polished off every one of them with bombs.

Four mines laid in a harbor on the coast of Indo-China made the Japs abandon the port. Finally, no Jap harbor in the home islands was safe for a ship.

But V-J Day posed another problem: how to find and destroy thousands of mines. In the war's first nightmare, we had mined defensively as far south as the New Hebrides. When the Jap found himself off balance, he, too, began mining defensively. Courage alone took American minesweepers into the waters off such places as Guam and Okinawa ahead of the assault boats. At Balikpapan, four out of every 10 sweepers were damaged or sunk.

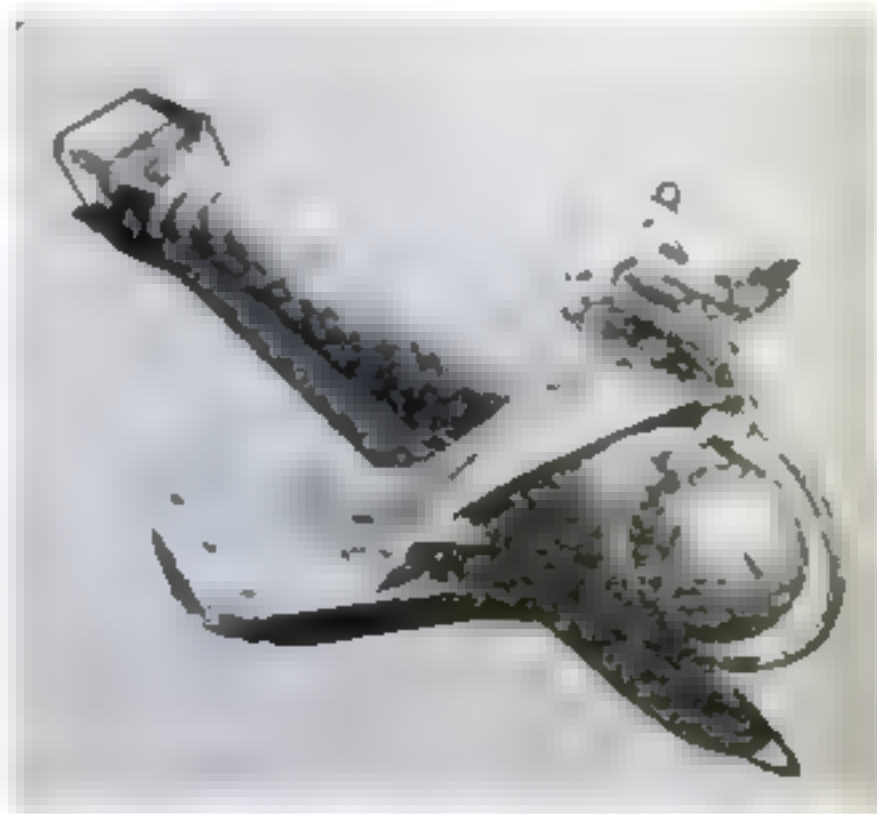
The Japs seldom used anything but simple "chemical horn" mines, which exploded on contact. But we sowed magnetic mines from airplanes with a lavish hand. Most of our magnetic mines had "sterilizing" devices to make them harmless after a time, but the sweepers can't be sure the devices have worked. Neither do the sweepers know exactly where those American-sown mines are. Pictures often were taken of them as they hit the water, to locate them with relation to the coastline, but they still may be anywhere within an area of several thousand square yards.

Marine growths can cover mines so fully that divers can't see them a few feet away,

yet not make them ineffective. And mines sometimes slip their moorings. Floating mines of the anchor type have been reported recently along the American west coast, carried there by ocean currents.

Detectives of the mining business then are summoned. If mines found floating in cold waters are covered with colonies of a certain kind of barnacle that thrives in warm waters, they know that the mine field is not likely to be near. Barnacles fasten on to things only near the surface, and a lot of barnacles indicates a long drift. One mine sleuth, notified that mines had broken loose from a defensive field near Trinidad, surmised that ocean currents eventually would carry them down to the coast of Brazil. They did, too.

Some of the many moored mines which the Japs laid will be hard to sweep because they "dip"—sink to a greater depth—in a current. The added weight of marine growths causes them to dip even more. If a sweep wire isn't set at exactly the right



An "otter" out of water, revealing the big knife with which it slashes the anchor cables of mines.

depth, it will pass over the mine instead of under it.

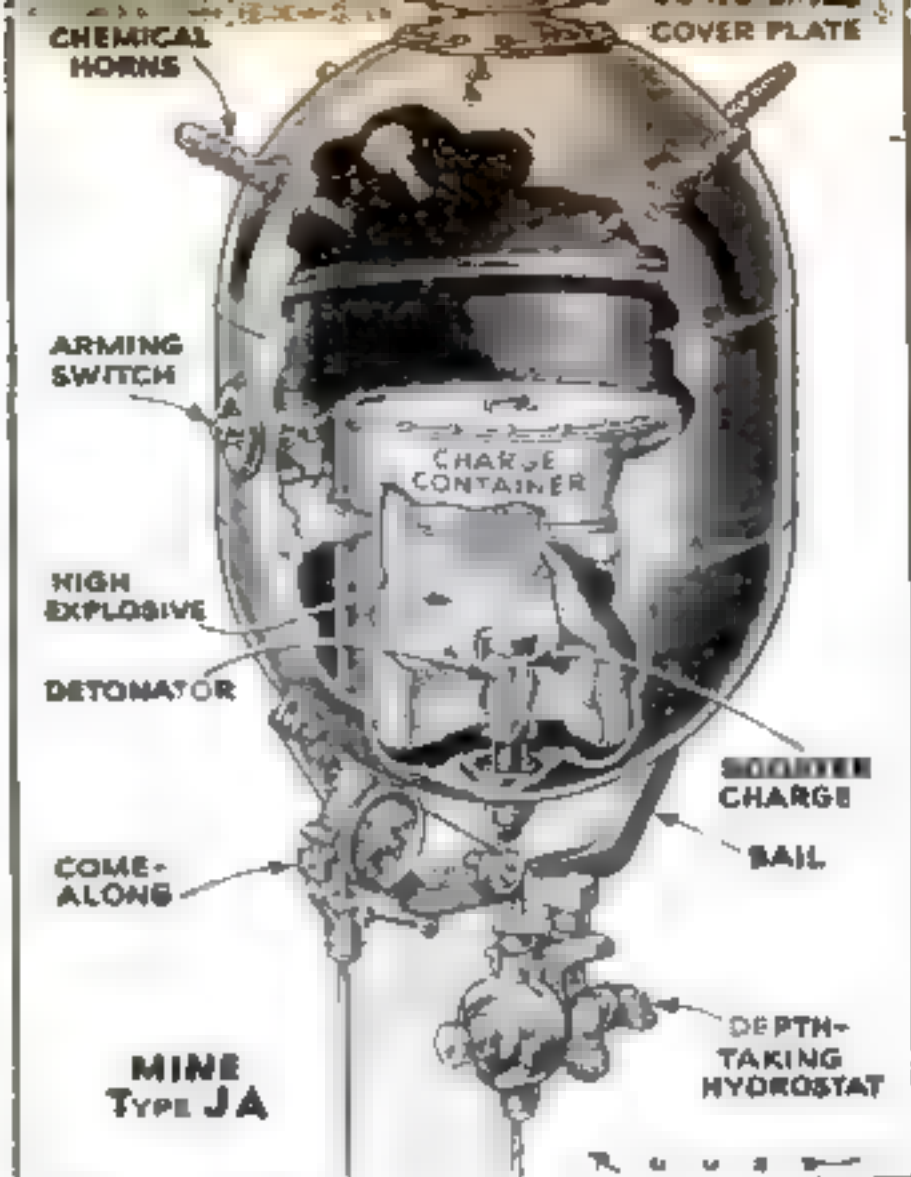
Naval mining experts would like to lay the ghost of the rumor, however, that a vagrant, floating mine is always a shipping hazard. The chances are 10,000 to one that it won't explode. All mines that are set off by contact are designed to sterilize themselves when they slip anchor. Even the Japs, who attacked without warning, saw to it that their mines sterilized themselves. They had to: a mine ready to go off is dangerous both to friend and enemy.

The 10,000 defensive mines we laid in 1942 and 1943 off Chesapeake Bay, Cape Hatteras, Key West, and Trinidad, off Kodiak in Alaska and Adak in the Aleutians, have been swept up as nearly as sweeping can account for them. Other U. S. coastal waters were defended by mines of the anchored, controlled type, built to go off when someone ashore throws a switch. They have been accounted for. Our fleet of about 600 sweepers has taken care of some 10,000 Allied and enemy mines.

TNT usually is the main charge in American mines. The Germans used it also, but added powdered aluminum to give their mines more "kick." A Japanese mine ordinarily contains picric acid, or combinations of chemicals and crude oil.

Many maverick Jap mines have been found, indicating a high percentage of improper "plants." The Japs also occasionally planted dummy mines: nobody knows why.

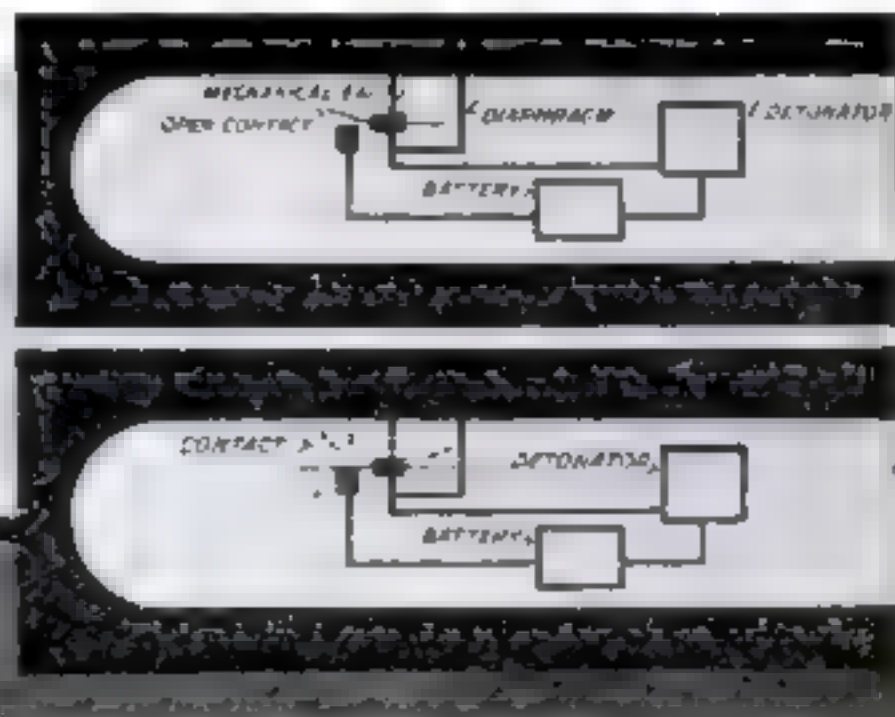
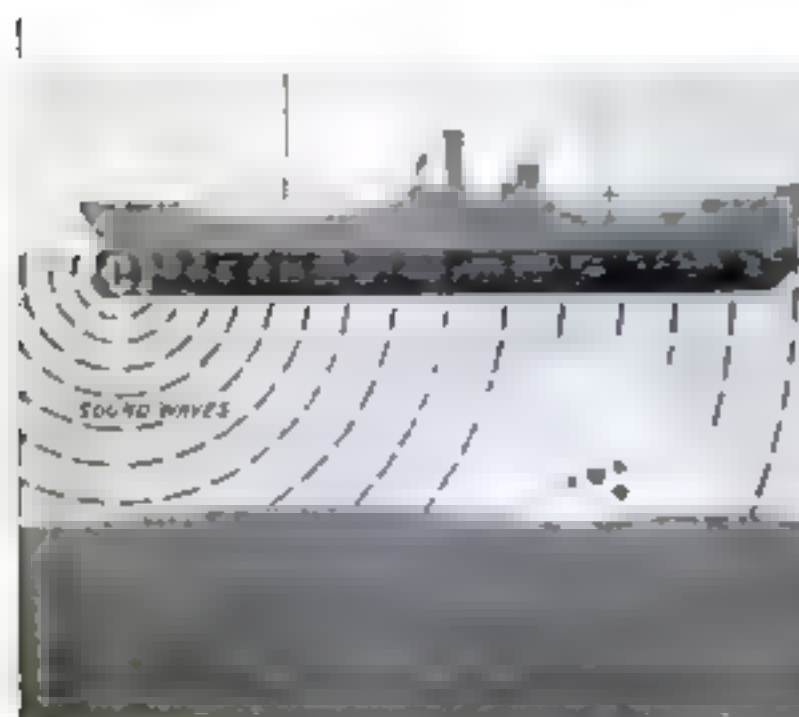
Minesweeping is under the immediate control of the individual fleet commanders, but the Commander, Minecraft, U. S. Pacific Fleet, is in charge of all U. S. minesweepers and other mine vessels in the Pacific. Under his command the vessels are organized into divisions and squadrons and then assigned to the various fleet commanders for specific



Japs used this "chemical horn" mine. When horn is crushed, acid energizes battery, sets off detonator.

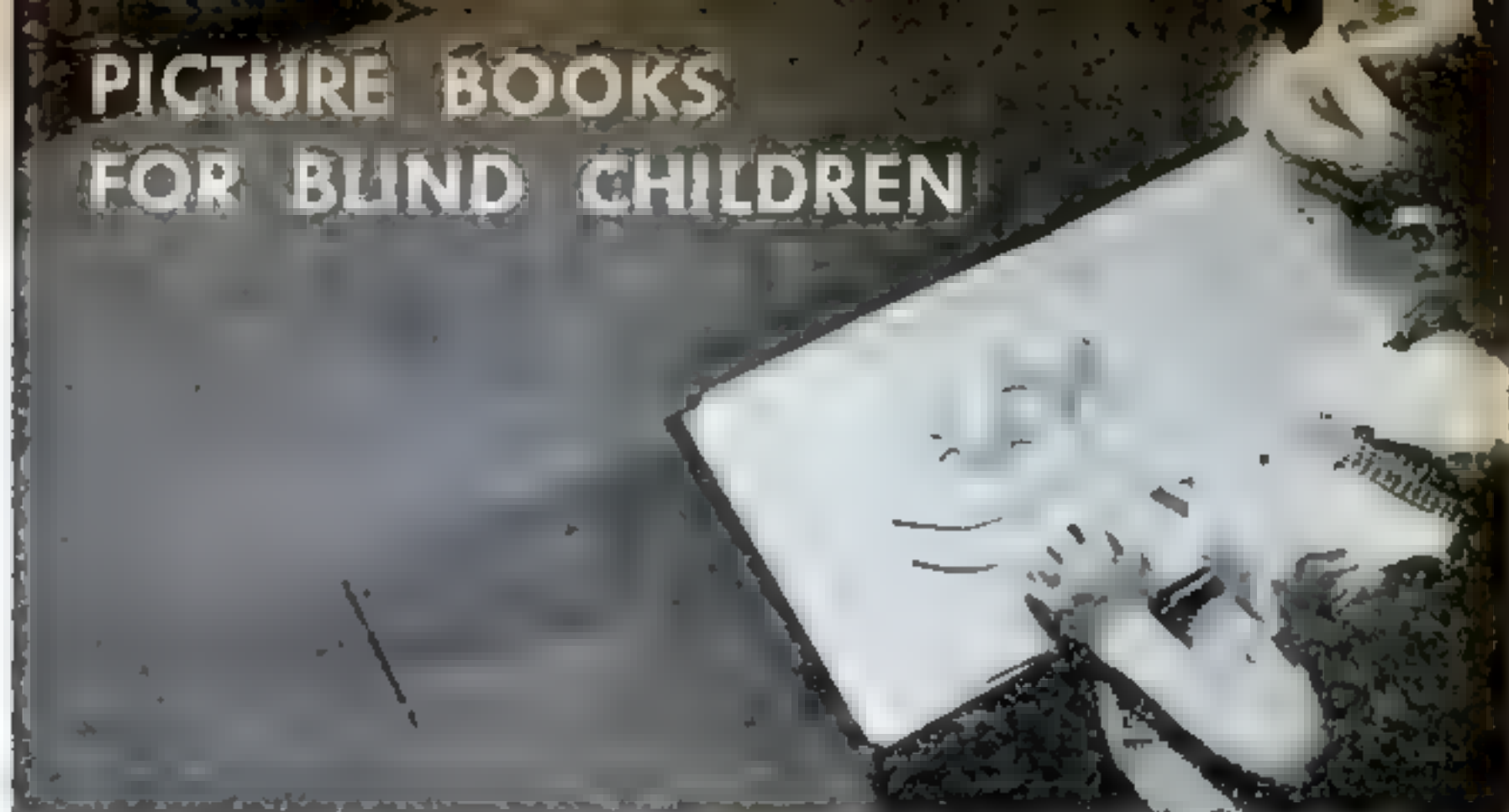
tasks. Back in Washington, appropriate bureaus of the Navy Department, under the over-all supervision of the Chief of Naval Operations, have set up training schools, experimental laboratories, building and testing facilities, supply depots and repair units, both here and overseas, to support the minesweeping forces.

How much longer it is going to take to complete the job depends in large part on the size of our postwar Navy; the smaller it is, the bigger the task. One unofficial estimate is that it may take a dreary three years. That's a long time after V-J Day for the men of the minesweepers.



This drawing shows how sound waves from an approaching vessel beat against the mechanical ear of a waiting ground mine and, as the schematic diagram indicates, activate the detonation circuit of the mine.

PICTURE BOOKS FOR BLIND CHILDREN



Angela Brown fingers a raised drawing in one of her parents' books showing how a blind child "sees" it.

ILLUSTRATED books for blind children said to be the first made, are being prepared and freely circulated by Mr. and Mrs. John Bass Brown, Jr., of Charlotte, N. C. It's a hobby, and one that their young daughters share. The Browns obtain publishers' and authors' permission to bring out special Braille editions of new books, with raised illustrations. Mrs. Brown pricks out the texts on Braille paper. On other sheets of it the family pastes cutout drawings that a cousin has copied on heavy cardboard.

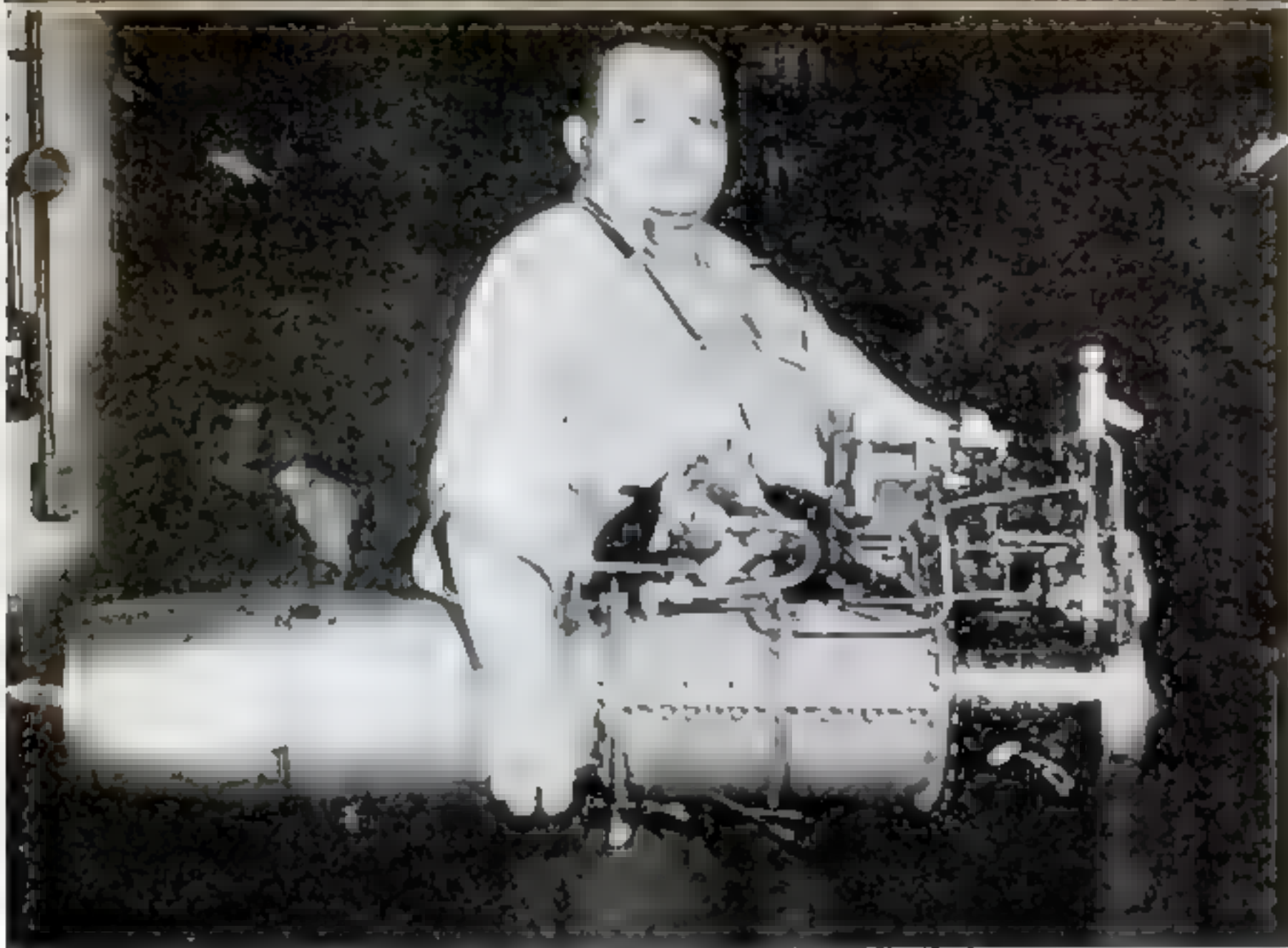
Little Mary Brown suggested the project. Angela, nine, chooses the picture books she thinks blind girls and boys will most enjoy. Her choices are popular, for demand for them far exceeds the supply.



Mrs. John Bass Brown, Jr., transcribes a children's story into Braille while her husband reads it aloud.

After cardboard cutouts of illustrations are added leaves of book are protected by coating of shellac.





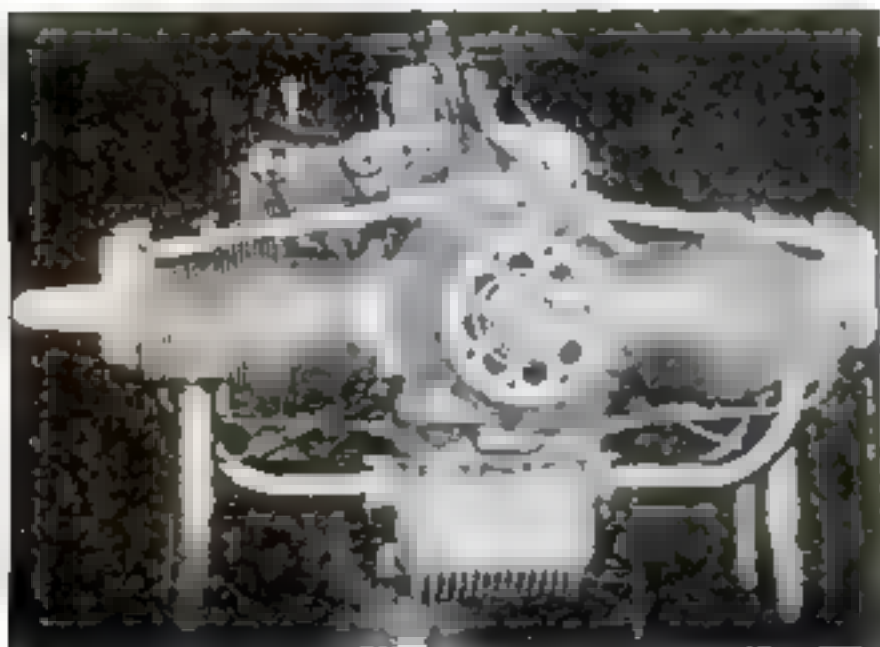
Tiny Turbo-Jet May Drive Helicopters and Lightplanes

THIS little jet-propulsion engine—it's only 9½ inches in diameter and weighs only 145 pounds for all its 275 pounds of thrust—was designed by Westinghouse engineers to power a Navy "buzzless" buzz bomb. Its turbine spins 34,000 times a minute, and its jet stream delivers 275 horsepower at 375 miles an hour. Aircraft engineers say it

may see service as a power source for aircraft cabin supercharging, wing de-icing, driving helicopters, and powering personal planes.

Utilized in a lightplane, however, it would drive a propeller rather than be used as a jet engine, since jets are inefficient at low private plane speeds.

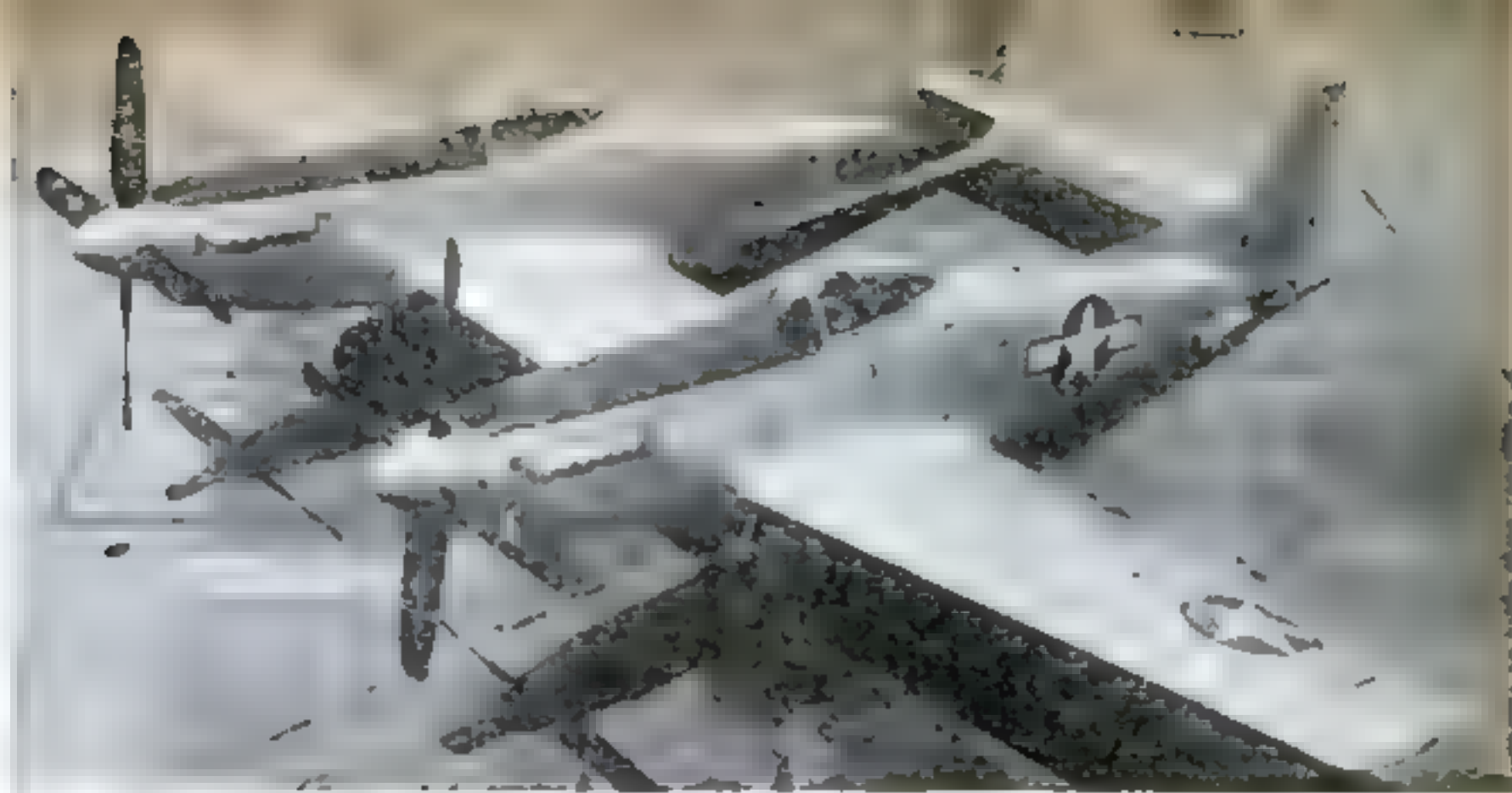
Lightplane Power Unit Uses Less Fuel Than Family Car



Simplicity of design of the  engine permits complete disassembly or reassembly in two hours' time.

THE Diesel engine shown at the left, designed specifically for low-priced lightplanes, will fly the average two- or three-place craft at a speed of 130 m.p.h. and consume only three gallons of Diesel fuel during an hour's sky ride. Currently selling at about seven cents a gallon, Diesel fuel will thus power the lightplane at one third the cost of driving the family car.

Designed by Fred A. Thaheld, the four-cylinder, air-cooled engine is being built by Diesel Power, Inc., Brea, Calif., in two horsepower—100 and 125, with all parts of both engines completely interchangeable. Weighing no more than the conventional gasoline engine, it can be installed in any lightplane without making any alteration in the plane's design.



The "Siamese" Mustang Spells Double Trouble in the Air

TWICE as powerful as the P-51 is this North American P-82B twin-Mustang fighter and attack bomber. It's in the 450-500

m.p.h. class and has a 3,000-mile range. Pilot and copilot in the separate cockpits spell each other to cut down flight fatigue.



"Static Dischargers" Drain Off Stray Electricity

"STATIC dischargers" foot-long wicks of cotton and plastic that dangle from the trailing edges of a plane's wing tips and

rudder and its stabilizer tips—gradually dissipate the electrical charges that might knock out an instrument.

British Plane Has 23 Wheels

WHEN this flying truck takes to the air and comes in for landings, it utilizes 23 wheels to bear its tremendous load. It is a British transport, the Arado 232B, and was regularly used in the war to carry tanks and big guns.



NOSE OF PLANE IS FULL OF RECORDING INSTRUMENTS PHOTOGRAPHED CONTINUALLY BY AUTOMATIC MOVIE CAMERA

YAW METER MEASURING SKIDS OR SLIPS IN TURNS

BY KILLING ONE ENGINE AND FULL-FEATHERING ITS PROPELLER, EXPERIMENTAL WING SECTION OPERATES WITHOUT EFFECT OF THE SLIP STREAM

ENVELOPE, OR FALSE-WING SECTION, OF EXPERIMENTAL DESIGN FITTED OVER REAL WING OF "SWORDFISH"

PILOT

ENGINEER-OBSERVER RIDES IN SECOND SEAT

COUNTER-BALANCE FOR ELEVATOR

STATIC TUBES TO MEASURE AIR FLOW OVER WING SECTION BEING TESTED

WING SLOT THROUGH WHICH PRESSURE OVER WING IS CHECKED

"Old Nosey" got its name from the five-foot yaw meter in its nose that indicates skidding and side slipping.

Swordfish Is World's Fastest "Flying Wind Tunnel"

THE Lightning Swordfish, an experimental modification of a standard F-35, has been testing wing designs of superfighters and transports secretly since 1943. Envelopes, or false wings, that cover a portion of the Swordfish wing are removable sections built with contours in exact proportion to any experimental wing proposed.

Fitted to test drag, lift, and airflow characteristics under actual flying conditions, the ship can dive at speeds of more than 525 miles an hour—the world's fastest "flying wind tunnel." In addition to the devices shown in the photo above, instruments in the nose are automatically read by a movie camera for permanent records of tests.

Navy's XF8B-1 Is Called the "Most Versatile" Fighter

CALLED the most versatile fighter in the world, the XF8B-1, developed by the Boeing Aircraft Company for the Navy, can be used as a bomber, torpedo plane, attack plane, or interceptor, or in many combinations of these types. After dropping a 6,400-pound bomb load, for example, the new

fighter will be capable of a speed far in excess of 450 m.p.h. If used as a torpedo plane it can be fitted with two 2,000-pound "fish." Armament consists of six 20-millimeter cannons mounted in the wing and sighted by remote control. The fighter's service ceiling is over 35,000 feet.

The XF8B-1's two 32-foot contra-rotating propellers are powered by a 3,600-hp Pratt & Whitney engine.





Transmitters at left give the differential analyzer its problems. It solves them on cylinders and typewriters in right foreground.

M.I.T.'s 100-Ton Mathematical Brain Is Now to Tackle Problems of Peace

THE 100-ton "brain" at the Massachusetts Institute of Technology is ready to turn its attention to complex problems of peace in every field of science and engineering. During the past three years, this giant calculating machine, deliberately rumored to be a "white elephant" to deceive the enemy, computed complicated range tables for U. S. Navy guns, supplied fire control data, and figured out radar antenna designs. In a few minutes, or in a few hours at most, it provided answers to these and other complex problems it would have taken trained men weeks to solve.

Able to tackle three problems at a time, with as many as 18 variables in any one, the calculator contains 200 miles of wire, 2,000 electronic tubes, several thousand relays, and about 150 motors. Yet, despite its apparent vast complexity, one man can operate it.

Technically called an "electro-mechanical differential analyzer," the huge machine is fed problems in coded symbols on perforated paper tape. It selects the units it needs, and gives its answers in numbers on electric typewriters, or as graphs on rotating cylinders, or both.



Inside of "brain" is a ceiling-high maze of wires, tubes, connections.

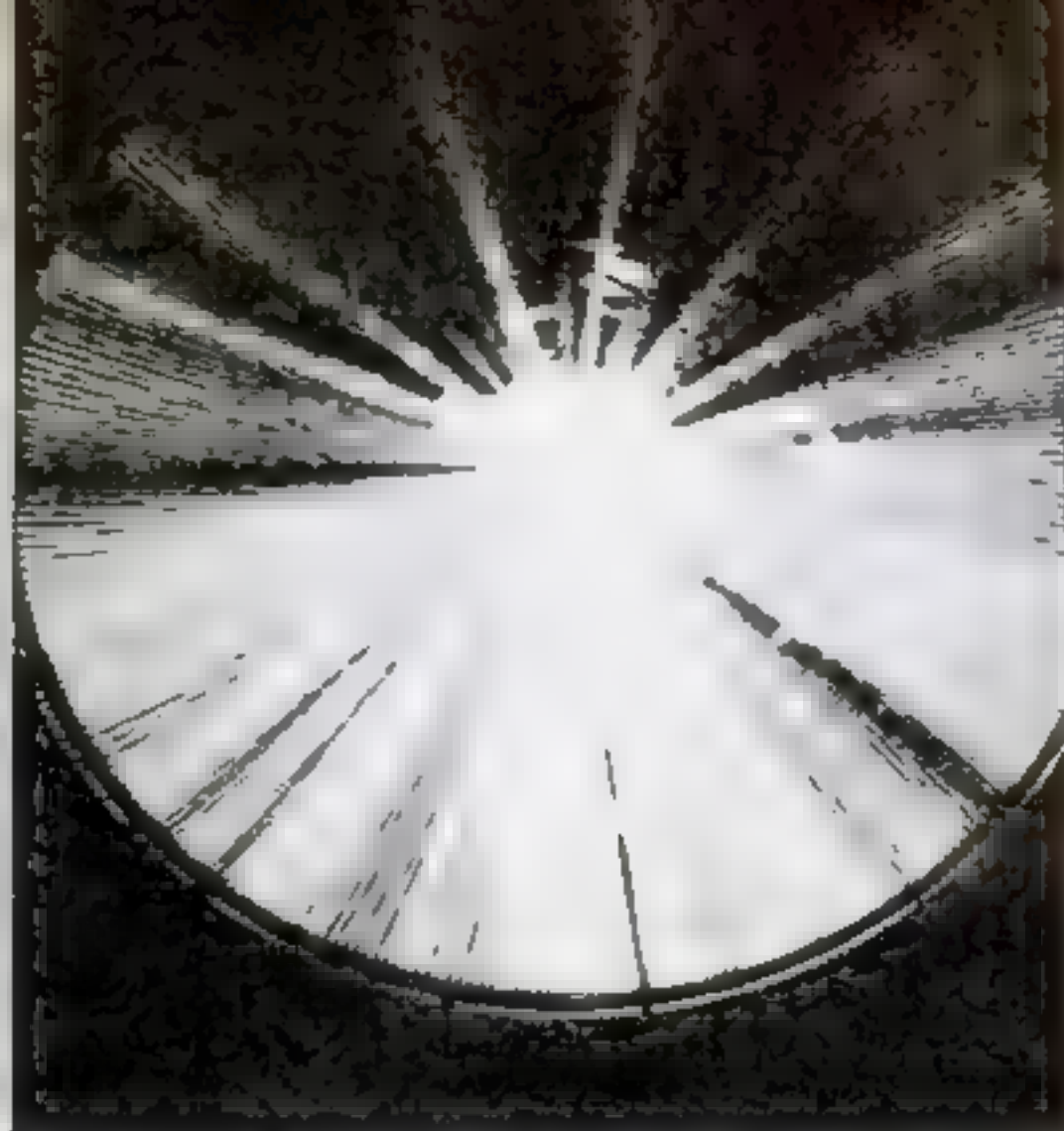


On this perforated paper tape, complex problems are given to M.I.T.'s huge calculating machine to solve.



"Hedgehog" Hurlled Deadly "Quills" at Nazi Subs

ONE of the most effective weapons in the United States Navy's long, grim battle against enemy submarines was the "Hedgehog," a novel depth-charge projector that was mounted on the bow of a ship and threw its charges forward. The depth bombs were carried on rows of "spigots," as the photograph at left shows; were propelled by cartridge charges, and could be aimed to bracket a fleeing U-boat.



An unjammed PPI (Plane Position Indicator) radar scope shows spots of light for each approaching plane. Electronic jamming (right), done with specially designed radio transmitters, blots out the targets.

FOOLING ENEMY RADAR

How "window," "rope," and "ferrets" scrambled German and Jap scopes to save U. S. lives.

"**O**PERATION Overlord," the invasion of Normandy, has gone down in history as the most stupendous military undertaking of all time. But it might have been history's bloodiest debacle if there had been no radar countermeasures. These were provided by the technicians in a top-secret "RCM" project.

The 200 miles of Fortress Europe between Dieppe and the Cherbourg peninsula bristled with radar stations. Two or more sets for early warning and fire control were installed at each of some 50 sites; in one section, these electronic watchdogs were only a mile and a half apart. If they had detected the departure of our sea and air armadas from Britain, murderous fire from the many coastal batteries and antiaircraft guns could have ruined the whole Allied plan.

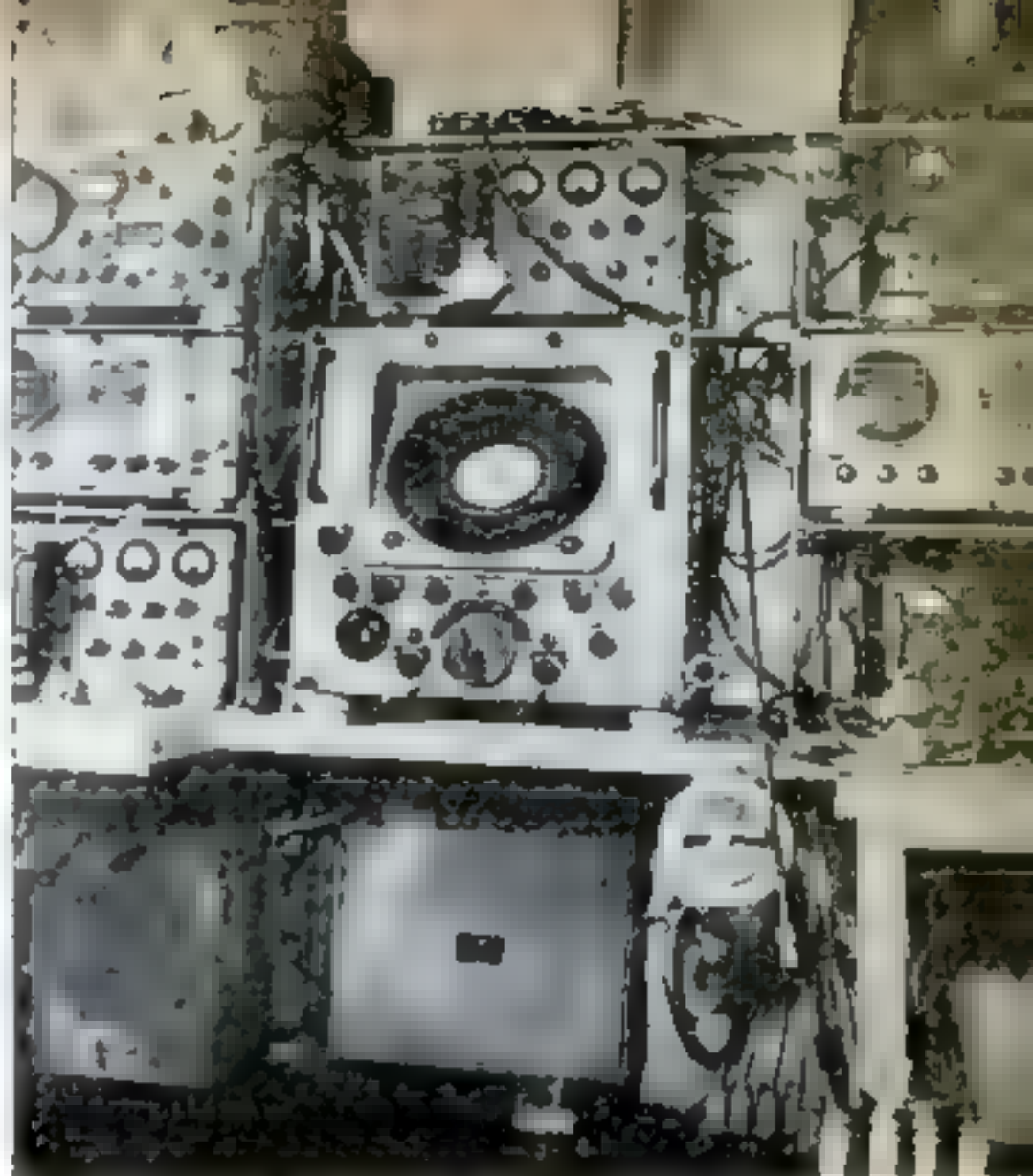
But several things happened to the Nazi radar network. Some stations were knocked out by gunfire, rockets, and bombs from pre-invasion air sweeps, but those remaining were the problem. Even three or four radars in operation would have tipped off the whole show. Those intact radars were made impotent by some of the cleverest mili-

tary legerdemain ever performed. A large Luftwaffe fighter force spent most of the night of June 5, 1944, and the following morning circling inland around Calais, looking for a ghost bomber force that never appeared. The antiaircraft "Würzburg" radar operators saw 20 times the number of planes—and there were plenty—that actually took part in the invasion. The "scopes" of Nazi gun-aiming radars were hopelessly cluttered with crazy-dancing lights, and others pointed the menacing coastal batteries toward spots in the Channel where there were no ships.

We foiled—literally and figuratively—Jerry's radar by dropping clouds of aluminum foil, the same silvery wrapping taken from chewing-gum and cigaret packages during the war years. These narrow foil strips that resembled Christmas-tree decoration were called "window." The rolls of long foil streamers that were used later in the war to clutter up Jap radars were known as "rope." Both the metallic strips and the ribbons were electrically resonant at the frequency of the radio waves sent out by the enemy radar. Hence, a few strips could return an echo in the enemy's radar



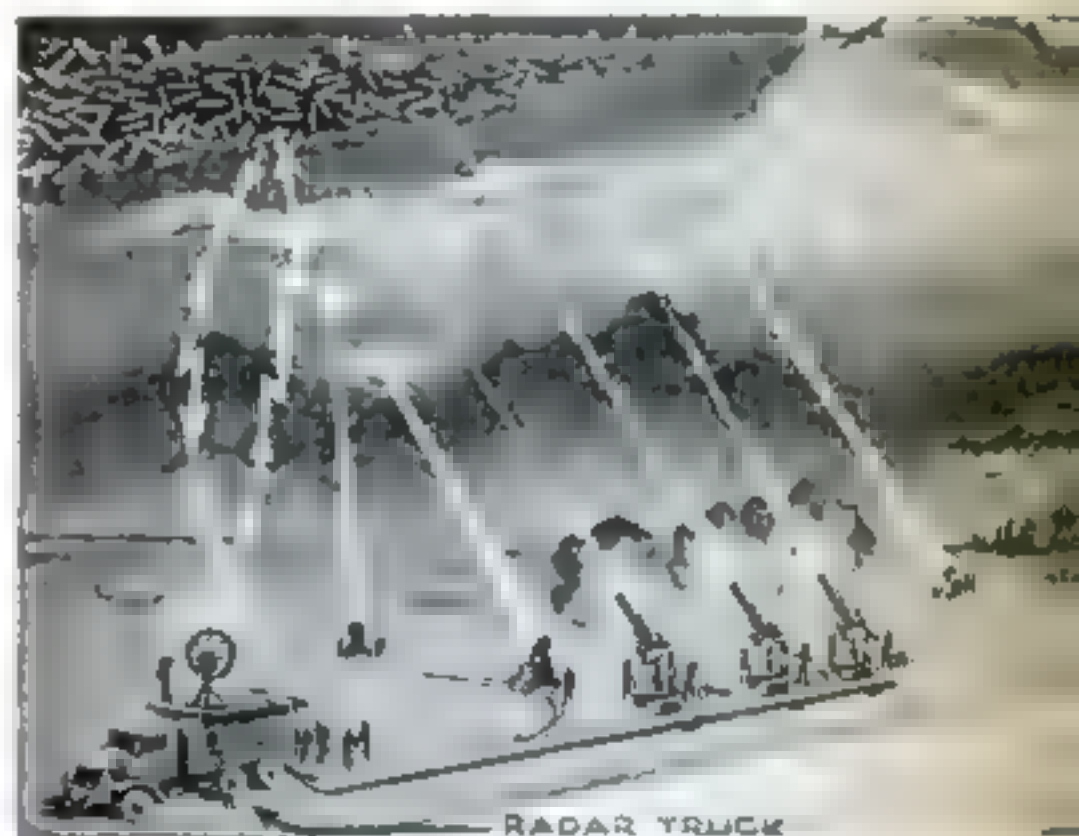
Spot jammers mounted in B-17s and B-24s blurred radar fire-control of German antiaircraft defenses.



A typical installation on a U.S. warship that located enemy's radar and shot out confusing signals.

scope that looked to him like a large object, such as an airplane or ship. A great quantity of "window" would light up his whole screen, so that the light "pip" that was really a plane was blanked out in the blaze of lights and shadows.

Another way of making an electric window in the enemy scope was electronic jamming. This was done with specially designed radio transmitters which could be carried in a plane or ship and used to send out signals that would cover up the enemy's radar signals. Radar works on the echo principle. A beam is projected outward or upward to scan the area for approaching planes or ships or other objects. When the high-frequency radio beam hits an object, a portion of the beam is reflected back to the radar, like a bouncing (Continued on page 22)



RADAR TRUCK



Flying above a cloud cover, a bomber drops clouds of "window"—strips of paper-backed tin foil—diverting aim of enemy guns while plane escapes (P.S.M., Sept. '45, p.69).

A captured German training film shows how Allied window jammed the "Würzburg" radar scope. Clear scope shows planes coming in at "3 o'clock;" right, window creates confusion.

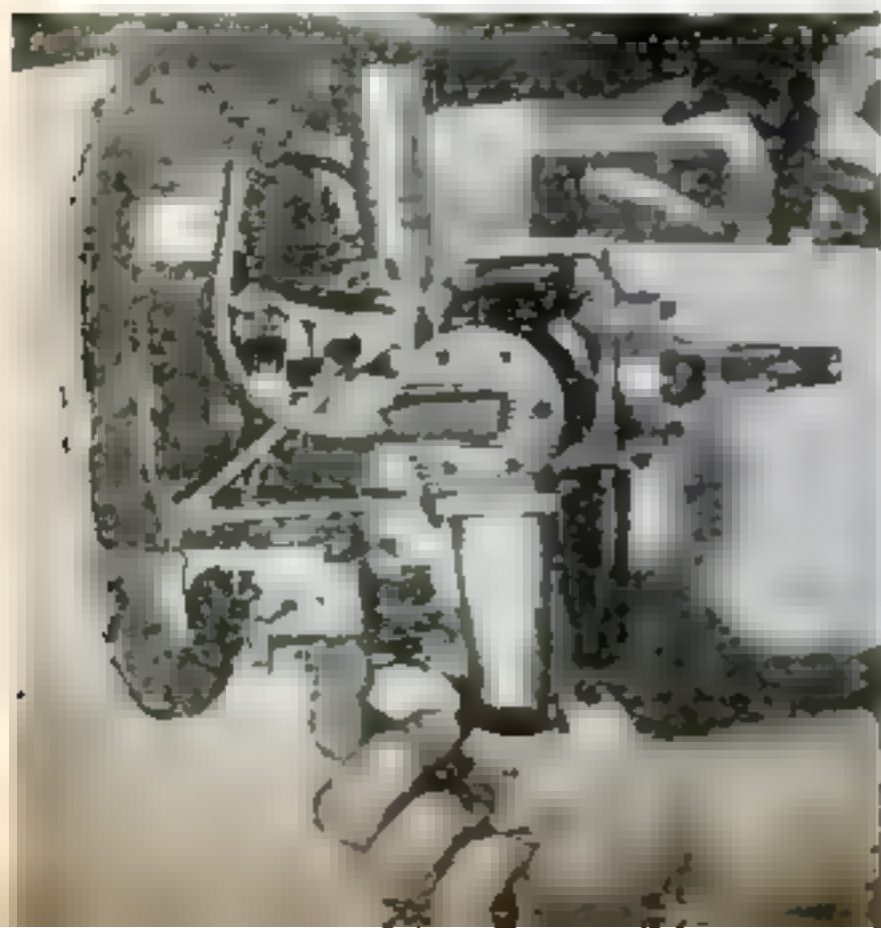


Designer adjusts the plastic-covered antenna. It takes three men (right) to start the midget engines

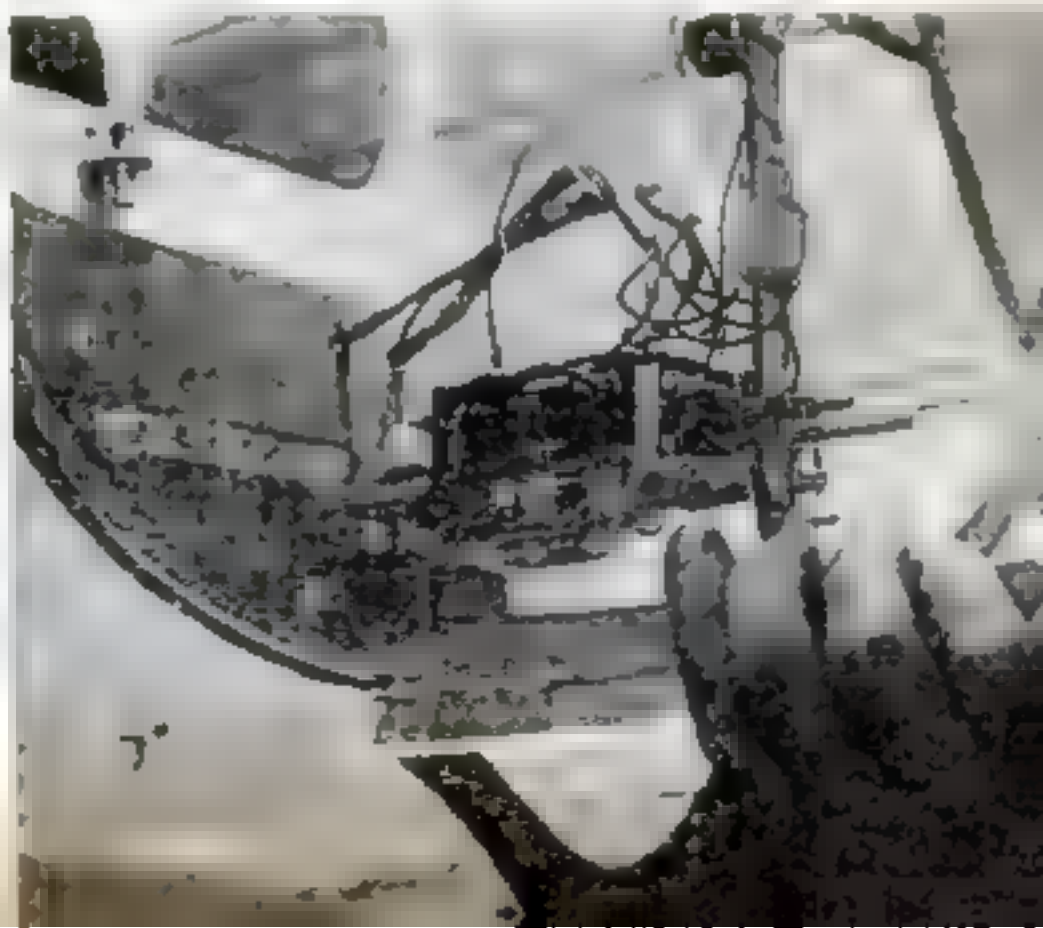
Radio-Controlled Flying Boat Tests Designs of New Craft

CONTROLLED by radio at distances up to 3,000 feet from the transmitter, the flying boat shown here climbs, rolls, dives, and descends gracefully to landings on the waters of San Diego Bay. Developed by Ernest G. Stout, of Consolidated Vultee, the twin-engine craft has a wing span of 13.75 feet and is 9.25 feet long. Each of its two-horsepower engines can spin the two-foot propellers up to 5,000 r.p.m. The pilot, sitting on the shore, controls the boat through a radio receiver in the hull.


Boat's radio receiver sets all controls through tiny servomotors. This one operates tail assembly



One of the two servos (below) that control engine throttles. Each motor weighs less than three ounces



NEW FIRE IN DIAMONDS



Splashes of light, made visible by thin cigaret smoke, show how a diamond's many-angled facets reflect rays.

First major improvement in diamond cutting in 300 years adds new facets and new brilliance to the stones

By ALDEN P. ARMAGNAC

GEM diamonds now appearing on the market have more brilliance and fire than ever, as a result of the first major improvement in the ancient art of diamond cutting in 300 years.

The more sides or facets that are cut in a diamond, up to a certain point, the greater its over-all brilliance—its total reflecting power. The facets multiply the number of paths which entering rays of light, rebounding like balls on a billiard table, may travel before emerging in the familiar glitter.

Meanwhile, the light rays are bent and split into rainbow colors, producing the bright-hued flashes popularly called the "fire" of a diamond.

It is possible to produce a diamond with hundreds of facets, but the tricky optical problem of arranging the faces at the most favorable angle to each other seems to set a practical limit.

Vincent Peruzzi, a 17th-century Venetian craftsman, believed he had reached this limit when he originated the 58-facet cut. Jewelers agreed with him until recently, and the American-type "brilliant" cut, a modern 58-

BRAB-CARTIER



A diamond's sparkle, photographed in clear air, spatters cardboard screen with luminous spots.



Exceptional flawlessness marks this rough diamond for distinction



Top is cut off first, leaving ample room above girdle for facets.



This angle is used almost universally when the bottom is cut off.



Similar cut completes rude shaping of jewel.



The intricate facets have now been formed on a rotating "lap."



Top view of the completed diamond, now it's ready to be set.

facet modification of Peruzzi's design, enjoyed unchallenged popularity.

From incoming European craftsmen, New York City inherited the father-to-son profession and became a diamond-cutting center in its own right. Leading gem designers applied the latest ideas in optics. Almost simultaneously, three New York firms came out with independent, patented ways of making "super-diamonds" with more than 58 facets:

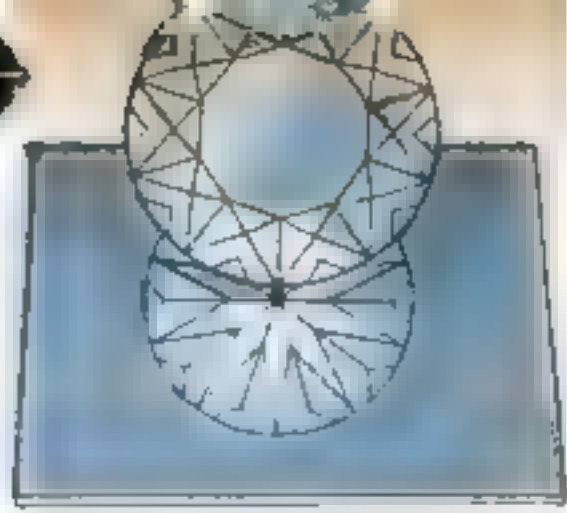
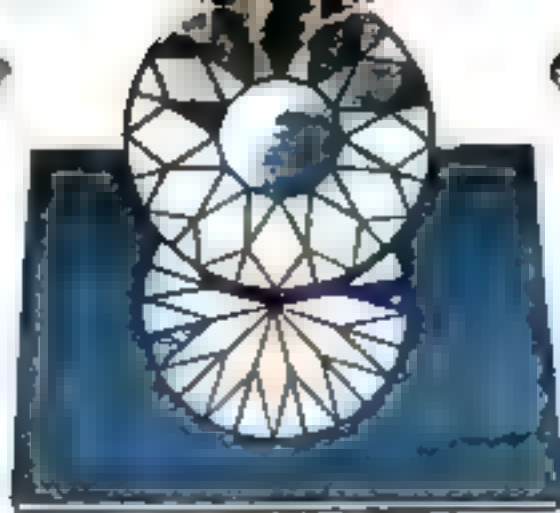
The King Cut, introduced by the King Diamond Cutters, provides 88 active light-reflecting facets, both above and below the "girdle" or edge of the stone. The large "table" or central facet of the upper side has 12 sides, instead of the traditional eight, and thus provides more edges to join symmetrically with other facets. Despite the delicacy of the work, this intricate design may be applied to all sizes of diamonds down to 12 points (12/100 of a carat).

The Multi-Facet Cut, pioneered by the firm of Louis A. Roselaar, preserves the general design of the "brilliant" cut. Extra facets of the newer design are added to what might be called the forgotten part of a diamond. A jeweler's "loupe" (magnifying glass) clearly reveals a thin, unfinished line of rough diamond at the girdle of a standard-cut stone. Separating the upper and lower facets of the diamond, this nearly microscopic band contributes nothing to brilliance. But in the Multi-Facet Cut, ex-

pert workers polish 40 facets into the perimeter of the girdle, making, with the original number, a total of 98. For the first time, every pinpoint on a diamond's surface contributes to its luminous quality. Light-measuring tests, conducted at the Electrical Testing Laboratories in New York by Dr. Frederick H. Pough, of the American Museum of Natural History, show an improvement in brilliance considerably beyond what a layman might expect from the smallness of the girdle facets.

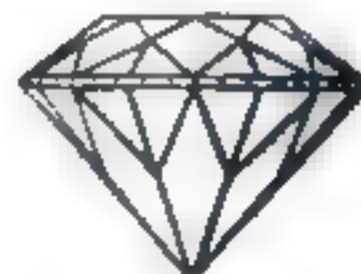
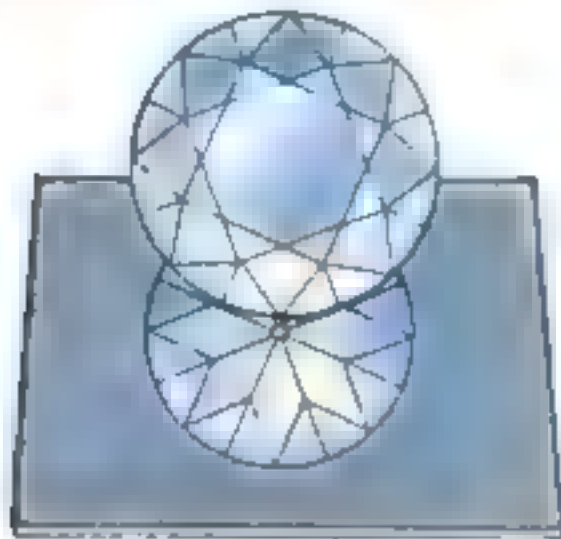
Radical departure from standard shapes and arrangement of facets gives the remarkable total of 102 facets to the Magna-Cut, created by George Fine, of Max Fine and Sons, Inc. One prominent innovation, a new shape for the top or table facet, makes it a 10-sided figure. Outlining this calls for a diamond cutter of exceptional skill. An eight-sided figure is easy: Nearly everyone can draw a fairly good square. Superimpose another square at a 45-degree angle to the first, and you have the eight-sided or octagonal table of the standard 58-facet brilliant cut. But drawing a five-sided figure, or pentagon, is not so easy. Nevertheless, the first steps in making the Magna-Cut call for outlining a perfect pentagon, and then another at a 36-degree angle to the first.

The increased skill and labor required in the latest cuts obviously add materially to production costs. Nevertheless, a customer may buy a diamond ring of one of the new



KING CUT diamond has 86 facets, in contrast to the 58 once thought to be the largest feasible number. Mirror helps show how 86 facets are arranged.

MAGNA-CUT diamond, still more elaborate, requires exquisite care in the delicate finishing process that gives it an unprecedented 102 facets.

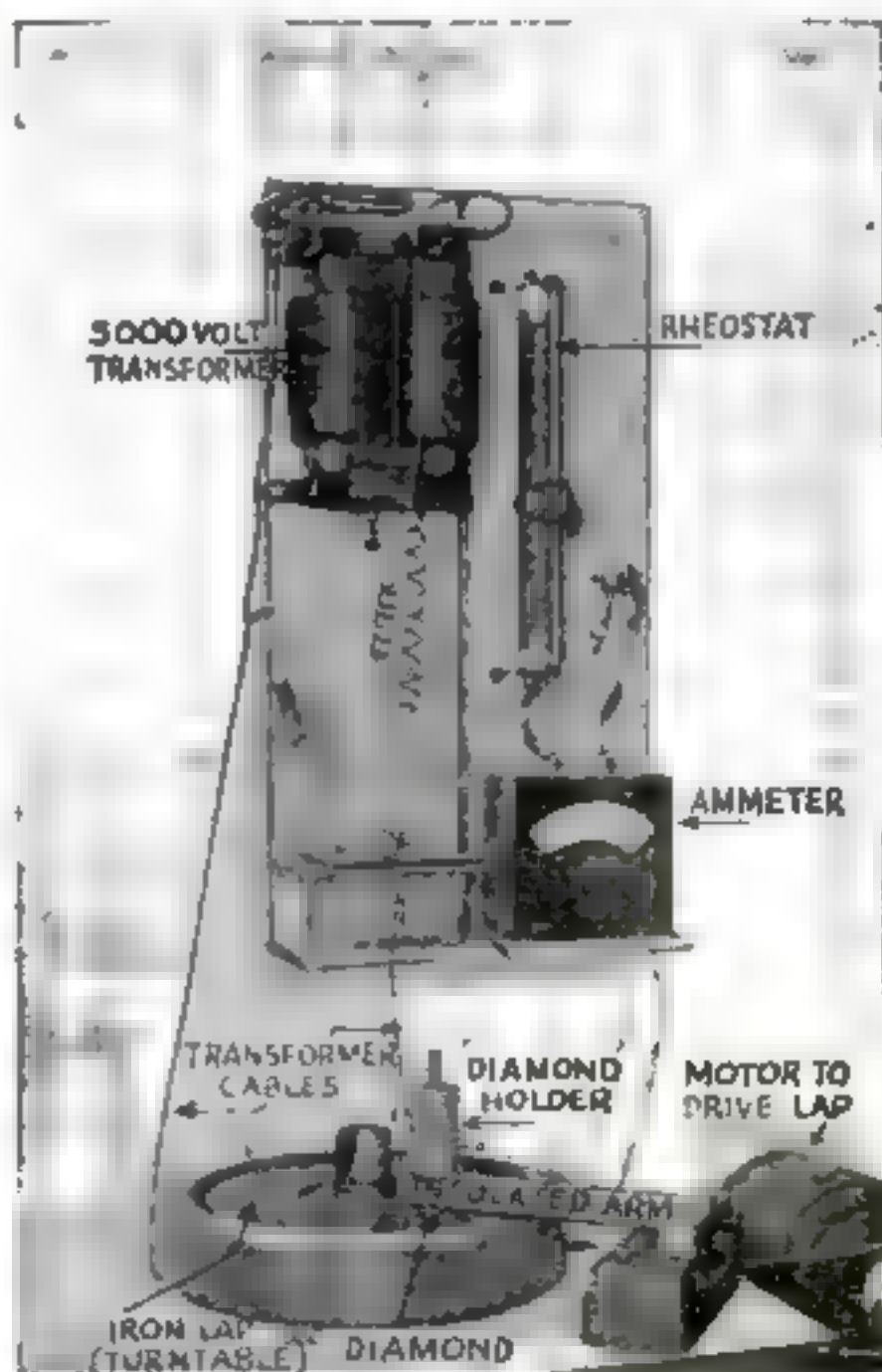


MULTI-FACET CUT diamond has the same fundamental design as the popular "brilliant" cut, shown mirrored at left, but 40 tiny facets are added to its girdle (above, right), thereby increasing the total to 98.

styles for as little as \$100. Only part of the extra expense is currently being passed on to the buyer, a poll of the makers shows.

The National Bureau of Standards reports that recent experiments prove high-voltage electric current speeds up both the preparation of rough diamonds from the mine and the addition of the last delicate facets. Unless it is certain that a large rough diamond can be cleaved by a knife blow along an expertly-figured plane, the big stone is sawed into smaller ones, using a small circular saw rimmed with diamond dust. This takes time, and no short cut was known until Bureau of Standards experts tried applying electric current between the saw and the diamond. The saw then bit into the diamond with magical effect. Even cuts at angles called impossible with respect to the axis, or grain, of the stone became child's play.

Next, the scientists turned to the time-honored process of putting the smaller facets on the gem—holding it, soldered in a handling tool called a "dop," against a revolving turntable of cast iron coated with a viscous paste of diamond dust. This apparatus, the "lap," bears a striking resemblance to a crude phonograph. Now, the experimenters achieved even more spectacular success. When a bluish electric arc appeared at the contact of diamond and lap, difficult cutting jobs were speeded up from months to hours! The discovery may lower the cost of really fine diamonds.



With this apparatus, experts have found that electricity greatly speeds the diamond-cutting process.



"Rita," new patrol bomber, had four turbo-supercharged engines, bad flight and cooling characteristics.

WHY JAP AIR FORCE DIED

U. S. Intelligence reveals errors, delays, lacks in design, development, production, pilot training that cost Nips control of sky

By PHILIP GUSTAFSON

Lieutenant Commander, USNR

IN A last-minute frenzy to find something that would stop our B-29s from destroying her industries and keep our fleets away from her shores, Japan was feverishly pushing the development of jet propulsion aircraft when Hirohito ran up the white flag. Considering their late start, our air intelligence found, the Japs had made amazing progress. Yet, however well it was planned, this hastily-built equipment proved to have too many bugs. Given time, the Japs would

have eliminated them. But time ran out.

This was one of the discoveries made by our Technical Air Intelligence officers at the Yokosuka Naval Air Station, the Wright Field of Japanese naval aviation, as they checked up on the newest wrinkles in enemy aircraft.

The Japanese aeronautical holy of holies was a straggling collection of thin-walled stucco buildings with flaking green-brown camouflage paint, flimsy hangars, and shabby aircraft parked every which way, some of them down on their knees from American strafing. On the surface, it



"Grace," monoplane with inverted gull wing, was fine torpedo bomber, with a 1,970-hp. Homare engine.



Keiun experimental fighter had six-bladed propeller, two engines behind pilot, and tricycle landing gear.



Baka 22 suicide plane would have been deadly if the Japs had got enough of them in the air at a time.



Jet exhaust of the Oka 22 a variation of the Baka. These tiny planes hit speeds of from 500 to 600 m.p.h.

wasn't much, but this was partly because there was so much beneath the surface. In the solid limestone of the Yokosuka hills were shops, hangars, storage and living quarters a whole experimental aircraft factory underground.

Inside the shops, however, were dirt and disorganization. Hand benches. Hand tools. The hammering out of little pieces. Scattered disorder. Everyone had apparently

worked in his own little messiness. There was no apparent clear flow of manpower effort.

"This was one of the very things that licked them," said Lieut. George Hall, USNR, grizzled, untiring, and tart of humor, who with Ensign Jimmy Wisely, USNR, went ashore with the Marines on August 30 the day MacArthur put his wheels down at Atsuki. His intelligence unit, which in-



Bi-fuel liquid jet engine intended for the Shusui interceptor (see page 90). Its fuel, T and C liquids, caused a chemical reaction in the combustion chamber that produced a high mass flow from the exhaust.



Axis-flow turbo jet engine used in two types of Jap planes, developed temperatures too high for any alloy steel their metallurgists could produce. Consequently, its full potential thrust was never used.



The Shusui was to take off on wheels, drop them, land on a single skid. It climbed 10,000 ft. a minute.

cluded representatives of the U.S. Navy, Army, and the RAF, was still living in front-line conditions when I arrived, cooking their own food, washing their own clothes, and flailing at fleas that abounded in the enemy's naval barracks.

"To my mind, the Japs were beaten before the first atomic bomb hit Hiroshima," Hall told me. "Their industrial system had been all but destroyed by our B-29's, their transportation system was breaking down, and all initial materials had been cut off by our subs and naval aircraft—stocks of aviation gas were so pitifully low that they couldn't even operate their current models. In semi-desperation they turned to rocket and jet-propelled development and committed all their remaining aircraft—between 8,000 and 10,000, they said—to Kamikaze attacks on our fleet. The Japs were a third-rate nation playing out of their league and the suicidal emotional drive they were try-

ing to inject into their people would not make up for their own shortcomings in modern science and production."

This was the air force that four years before had challenged us to the heavyweight championship of the East and taken on the British on the side. And during the dark days of '42 its plagues of Zeros had come close to holding it. Then how did the mighty fall so low?

Admiral Hideo Tada, Chief of the Naval Experiment Station at Yokosuka, said one of the main reasons was the delay in replacing the Zero-type fighter.

"The high command was lulled into a sense of false security by the early successes of this plane, while your air force, with the sting of early defeat, began building on your Hellcat," he explained. "It was the Grumman Hellcat that beat Japan. When our high command did decide to put in mass production a plane to compete with



Tenrai, intended night fighter, had two 1970-hp. Homare engines, was planned to be one- or two-seater.

your F6F, it was too late. We ran into design and production troubles. Then material shortages. In the end, we couldn't get the new fighters out in quantity."

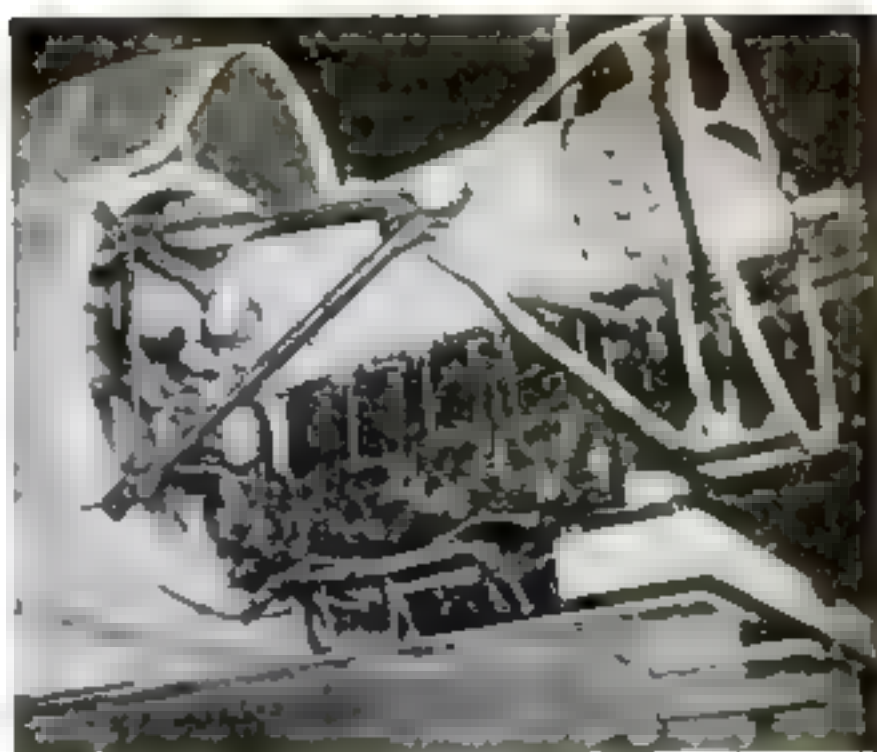
Commander Yukio Otsuki, one of the chief designers; Vice Admiral Misao Wada, Chief of the Air Service Bureau, the Japanese counterpart of our Bureau of Aeronautics; and Vice Admiral Munetaka Sakamaki, one of the Navy's chiefs of air operations, told me the same story. Some of them blamed the delay on the General Staff and some on the fliers in the field, who clung to the idea of maneuverability. Admiral Wada said he had offered plane designs three years before with better armor, self-sealing tanks, and firepower but he had been turned down.

The story of the belated fighter development, as gathered from these different sources and from the confiscated aircraft themselves, is this:

Finally convinced of the inadequacy of the Zero, the General Staff ordered its designer, the great Horikoshi, to produce out an up-to-date fighter. Horikoshi went to work on the Reppu (Strong Wind) which turned out to be a gentle breeze. The trouble came when the Jap engineers, cut off from the countries they had always copied, had to turn to and bring out engines of their own. This same shortage of creative engineering talent, incidentally, showed up in other fields and proved to be one of the basic factors in Japan's undoing.

The Homare engine was the white hope to power the Reppu but it ran into bugs and more bugs. The electrical system was a nest for some. The lubrication system bred others. All of the headaches added up to a year and a half's delay and during this time the designers turned to the 18-cylinder Kinsei. This 18-month delay was fatal. Otherwise, said Admiral Wada, the picture might have been different, for the new plane was more maneuverable than the Hellcat, had good protection and heavier guns.

While Horikoshi was sweating out the Reppu, Kawanishi came forward with a proposal to make a land fighter out of the float plane, Rex. The offer accepted, this plane was developed into the George 11. It was a good plane except that its aerodynamic characteristics were bad and the modification problems presented more difficulties than the hard-pressed Japs had time to contend with. They settled on mass production of the George 21—1,000 a month—but they overestimated their manufacturers, considering the problems of dispersal and material shortage that were then arising. The Japs say that if they had had the George 21 six months sooner, they would have discarded their other planes even to



Jet with an internal combustion engine, copied from Italian Campini, powered dangerous new Baka 22.



Pilots learned to launch and maneuver Baka planes in this trainer, Baka 11. It had flaps but no power.

the old faithful Betty, and concentrated on this fighter.

As it was, when we walked in on the Japs we found their Navy with two good first-line interceptors in production—the George 21 and the Jack 34. With another six months to work the bugs out of George's landing gear and Jack's supercharger, Jap engineers would have brought these planes to the point where they spelled trouble for us. But for any change in the outcome it would still have been necessary to get the fighters into mass production, train pilots, and provide good maintenance. They were a good two years too late.

When their reconnaissance and air-raid warning system broke down, the Japs were wild for something that could get up in the air fast enough to stop the Allied bombers which were making a shambles of the home islands. It was then that, in their desperation, they turned the heat on jet propulsion.

They had reached the test model stage in a B-29 interceptor (Continued on page 214)

MAN-MADE SUNSHINE

Solar benefits of a fine summer day at the seashore now can be duplicated under lamp-filled glass ceiling

ALL the rays of sunshine at the seashore now can be delivered almost anywhere. Simulating sunlight requires only a few thousand foot-candles of ordinary light, but more invisible than visible rays are needed to synthesize sunshine. It has been done, however, with the rays of 423 lamps, of six types, in the new "sunshine ceiling." The lamps are standard types, but so many are needed that a "cloud" of glass and running water is necessary to carry off some of the heat.

Designed for hospitals or institutions requiring constant sunshine for plant research, the synthetic sunshine was demonstrated this winter at the General Electric laboratories in Nela Park, Cleveland.

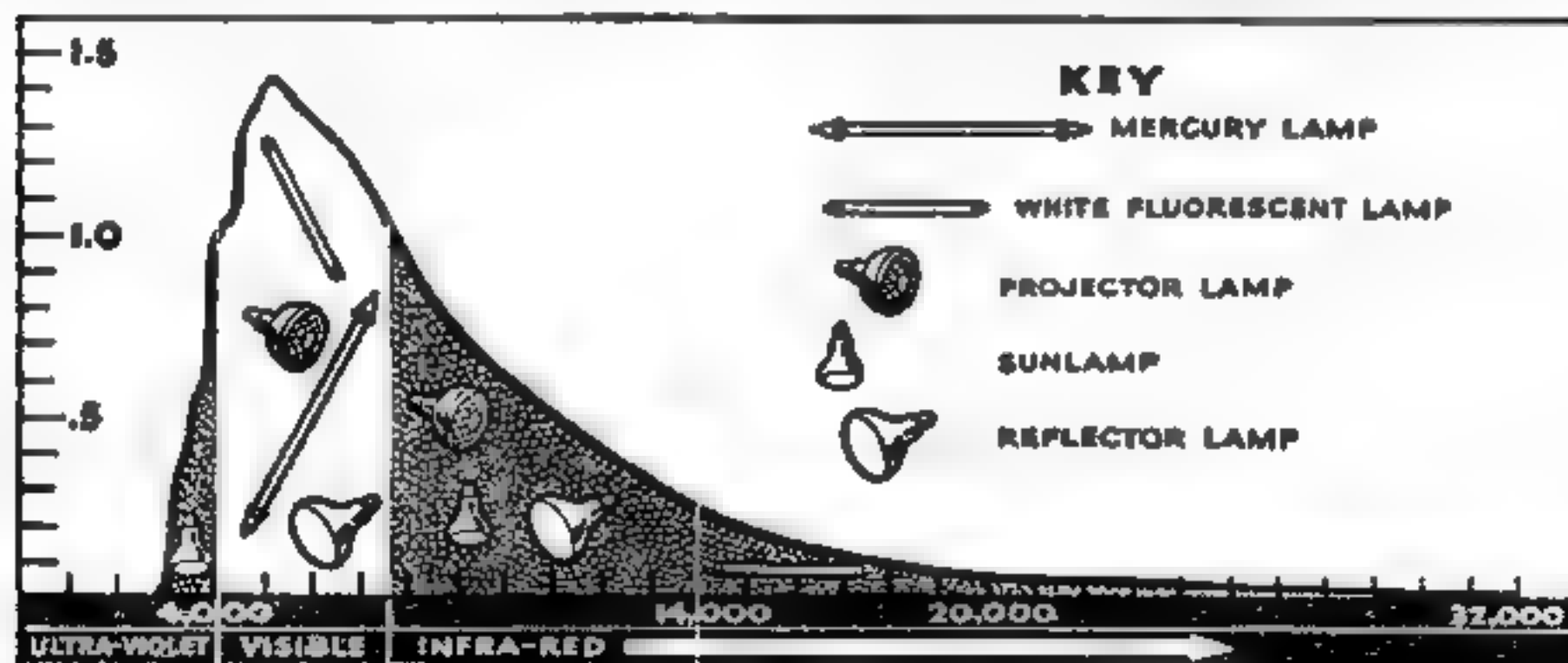
All light is atomic. By breaking the hearts of atoms, the sun emits so much radiant energy that it sometimes exerts nearly 100,000 tons of pressure on the earth. The explosion of an atomic bomb probably produces even more light than would be found on the sun's surface, but it is emitted for only an instant. The sun's radiant energy would burn us all to a crisp if we were not protected by the atmosphere.

More than half of this energy is infra-red rays, which we feel as heat, and about a twentieth of it is ultraviolet rays, which include those with germicidal effects and those that tan us. We see by means of rays between these two extremes. The oxygen,

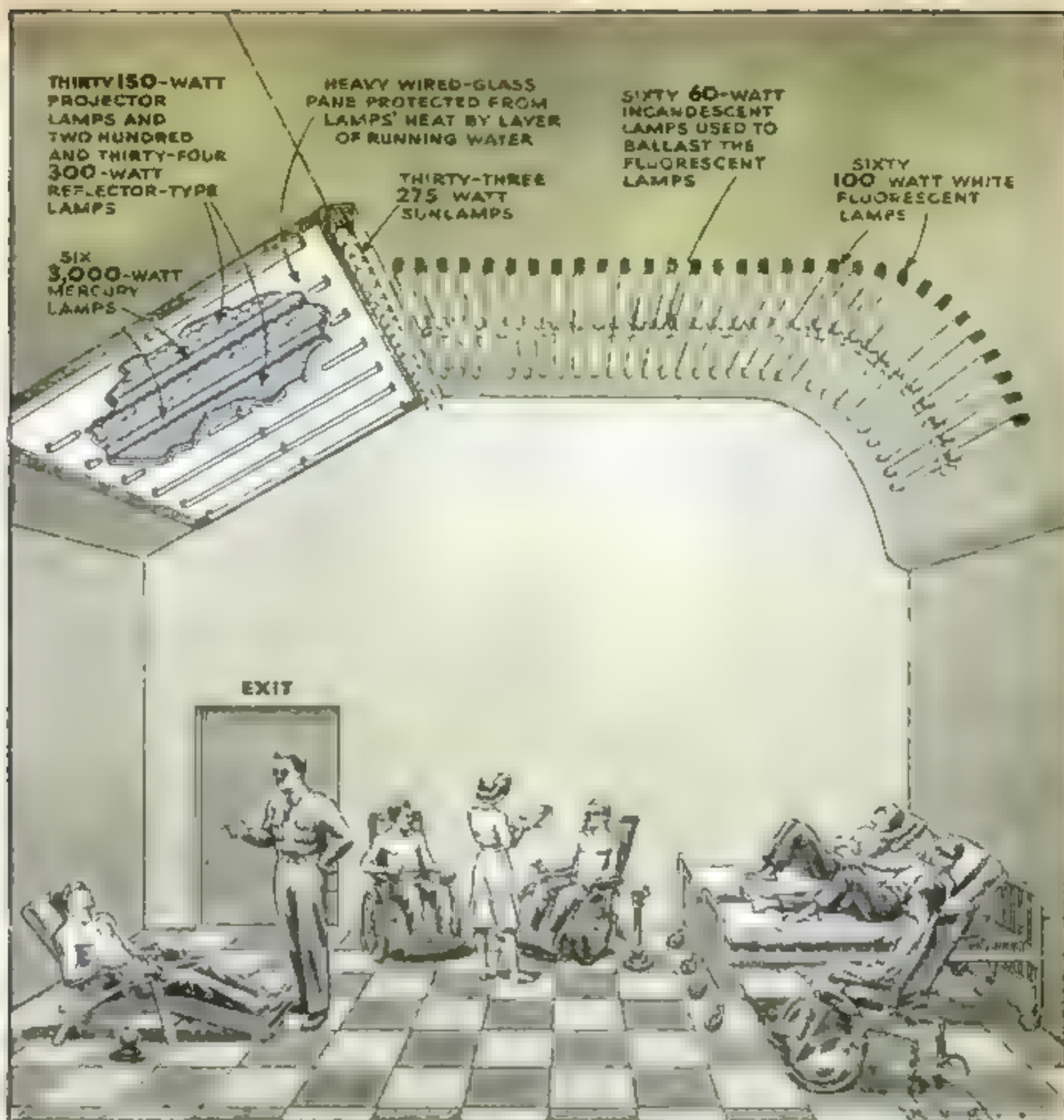
carbon dioxide, and moisture in the air absorb various amounts of these various rays. Sunshine, moreover, varies according to the season and latitude, and from day to day. To simulate sunshine, therefore, the scientific artists had to choose a day as their model. They chose a nice summer day at the seashore.

Dr. Matthew Luckiesh computed the amount of each kind of radiant energy that would reach a bather on such a day. G. F. Prideaux and other engineers then determined the kinds and numbers of lamps that would be needed to synthesize sunshine. At power rates, the 423 lamps they selected could be lighted for 24 hours for about \$32, but the heat from such a battery of lamps would be too great for comfort.

So the engineers placed the fluorescent lamps and sunlamps in one side of the ceiling of a room 28 by 14½ feet, and concealed the others behind a wire-glass skylight, over which they could keep water running. The smooth side of the glass skylight was placed toward the lamps at first, but the water running over it did not distribute itself evenly enough and the heat broke the glass. This difficulty was overcome by turning the hammered, or roughened, side of the glass toward the lamps. Then, by running a stream of 1,000 gallons of water an hour over the skylight, and supplementing this cooling system with electric fans, they found



Mountain of light shows how sun's radiant energy, in watts per sq. ft. per 100 Angstroms (on the vertical scale), is distributed to summer bathers and how it is duplicated by lamps. An Angstrom unit, one ten-millionth of a millimeter, measures wave lengths of sun's rays (horizontal scale). Waves of sun's rays vary in length from 3,000 to 30,000 Angstroms, but only those 4,000 to 7,600 Angstroms long are visible.



Indoor sunshine all the year around can now be obtained where needed by means of the installation diagrammed here. It is as hard to look at as the sun, but as enjoyable and beneficial as basking on a beach.

that excess heat could easily be carried off.

Further research may make it possible to synthesize sunshine with fewer, more efficient lamps. The invisible infra-red and ultraviolet rays are no more difficult to produce than visible rays. In fact, they sometimes get in the lighting engineers' way. Ultraviolet rays are produced first in a fluorescent lamp and changed in wave length to produce visible light.

The efficiency of electric lights is measured in lumens—one lumen being the amount of light that would fall on each square foot of a sphere with a radius of one foot, when placed around a light with the power of one candle. The highest possible

efficiency at which white light can be produced, according to Dr. Luckiesh, is about 200 lumens per watt. Fluorescent lamps now in use produce from 30 to 40 lumens per watt, and engineers are now confident that such lamps will be made even more efficient in the future.

"Considering these and the high-pressure mercury arcs," says Dr. Luckiesh, "we may soon have 100 lumens per watt. These lamps will make it easier to produce the levels of illumination that science has shown to be ideal for maximum human efficiency, safety, comfort, and welfare." Meanwhile, "summer sunshine" can readily be obtained wherever needed with the lamps now available.

SNOW SHOVELING

Army methods keep transatlantic air lanes open



As a Douglas C-47 takes off from a snow-cleaned area, a Sno-go eats up remaining drifts between runways.

CROSSING the North Atlantic by air, once the feat of fools, but now merely the quickest distance between two points, has been made safer for civilian travelers by the world's biggest snow shoveling job. Proper use of equipment and the development of new snow-removal techniques have made possible year-round use of our northern transatlantic bases.

The engineers of the Air Transport Command learned their know-how the hard and cold way, when our tactical aircraft had to use these bases, snow or no snow. The lessons are now paying dividends literally—in cash—for the commercial operators who are using these war-built air bases.

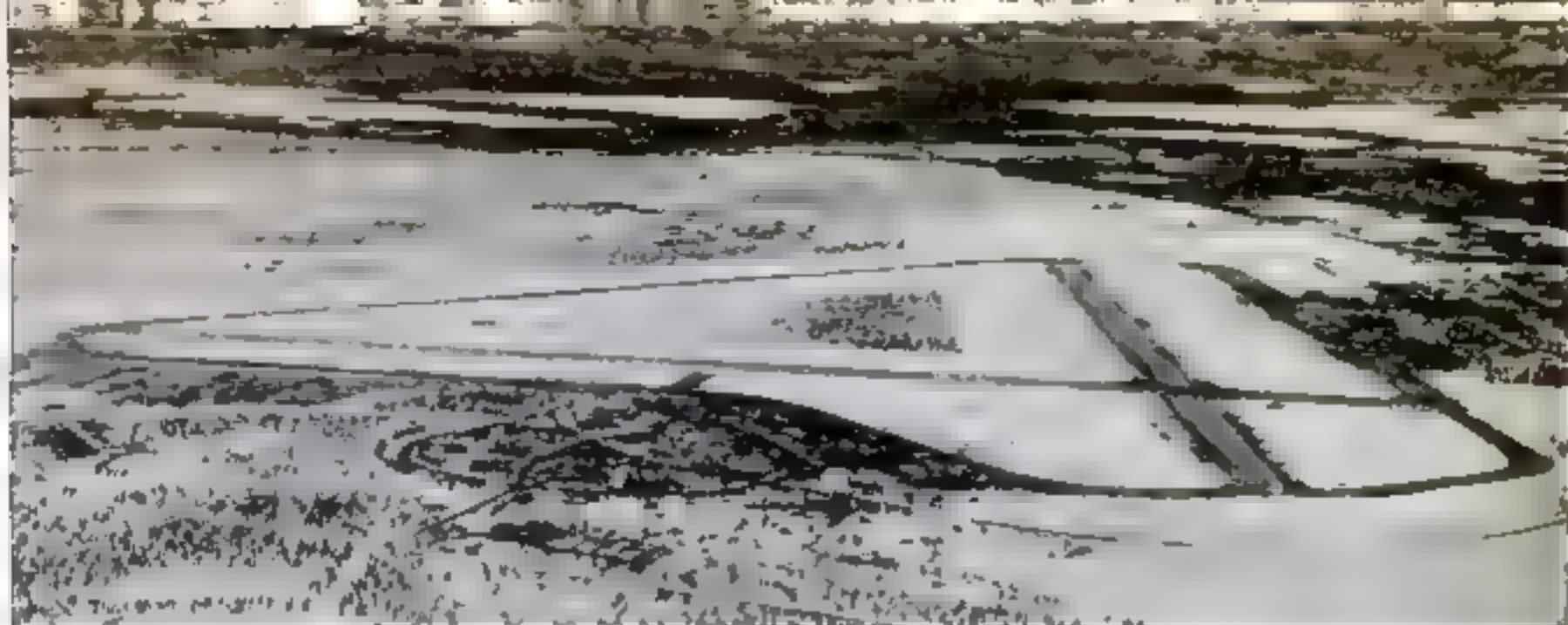
With winds often more than 100 miles an hour, "horizontal snow storms" strike North

Atlantic bases with little warning, and present problems unknown to either country or metropolitan snow gangs in the U. S. Regardless of wind, the runways must be kept clear of snow, and icy surfaces made safe for air traffic roaring in and out around the clock. The planes must land for servicing, refueling, delivery of cargo. More important, for the care of wounded men who are still being returned by air.

At some bases I have seen drifts over 20 feet deep, and have had to yell for four GIs to help me open an outside door against 50-mile-an-hour gusts. Coming with such gales, snow presents to the base engineer in charge of snow removal an enemy as dangerous in peace as any encountered in actual combat. Arctic storms are sudden. Often a gale will



Equipped with a loading scoop to direct the flow of snow, this type of snow-eater fills a moving truck.



This ATC base for the North Atlantic Division has three 6,000-foot runways that must be kept clear of snow.

bring a white wall of snow so thick and smothering that trucks, tractors, and other outside equipment are completely buried before they can be readied for action. An arctic storm can also be capricious. It may reverse direction and uncover these same trucks in a matter of minutes and sweep its own snow off the runways right down to the bare concrete.

This changeability of the wind is an obstacle to safe snow removal at many bases. For example, planes are due in two hours; a storm is raging; all equipment is working at top speed to clear the upwind runway. Thousands of square yards of runway have been pretty well cleared in the two hours, and the exhausted snow crews are listening for the motors overhead. Just as the planes are beginning to let down for the field, still several miles away, the wind shifts. Instantly, two hours of work are lost, for the planes must land upwind, and the runway that is now upwind is not usable. The crews and equipment must switch to the new upwind runway and open the second runway while the planes circle anxiously.

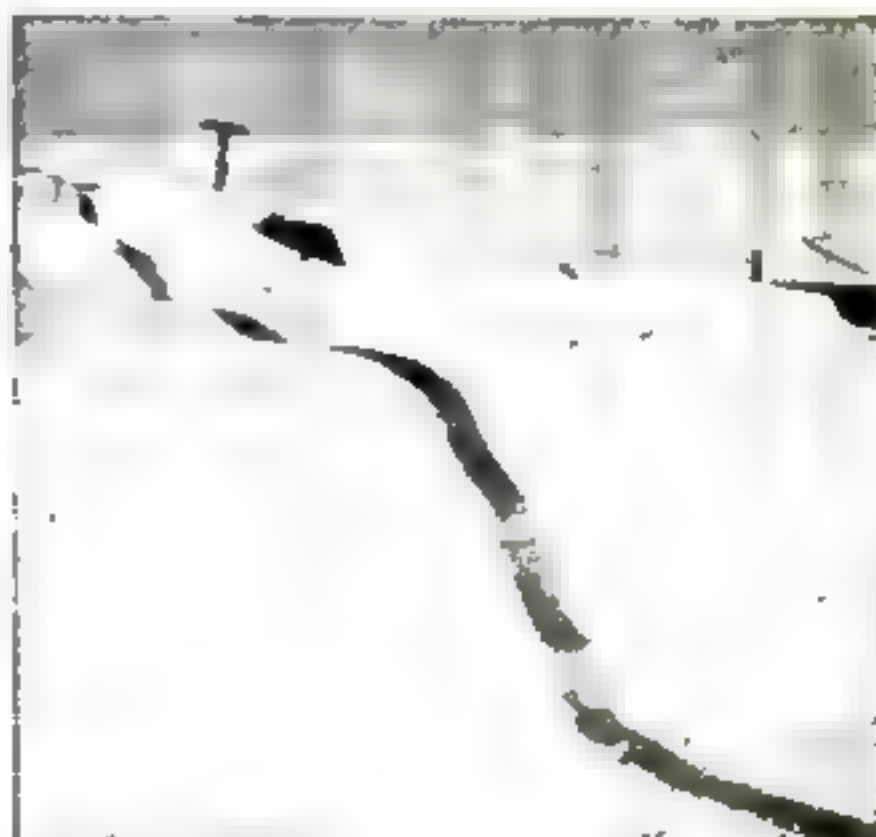
It was in this tough school that engineers of the North Atlantic Division of the Air Transport Command devised the methods of clearing runways and taxi strips that keep the ports open.

A combination of equipment is used. First, angle plows or scrapers move down the center of the runway, clearing a path the entire length. Behind them come other angle plows or scrapers moving the snow still farther back in mounting windrows. These 10-foot scrapings soon pile up into ridges that this equipment cannot budge. Then the Sno-go equipment enters the battle, moving down the runway in the wake of the angle plows and scrapers.

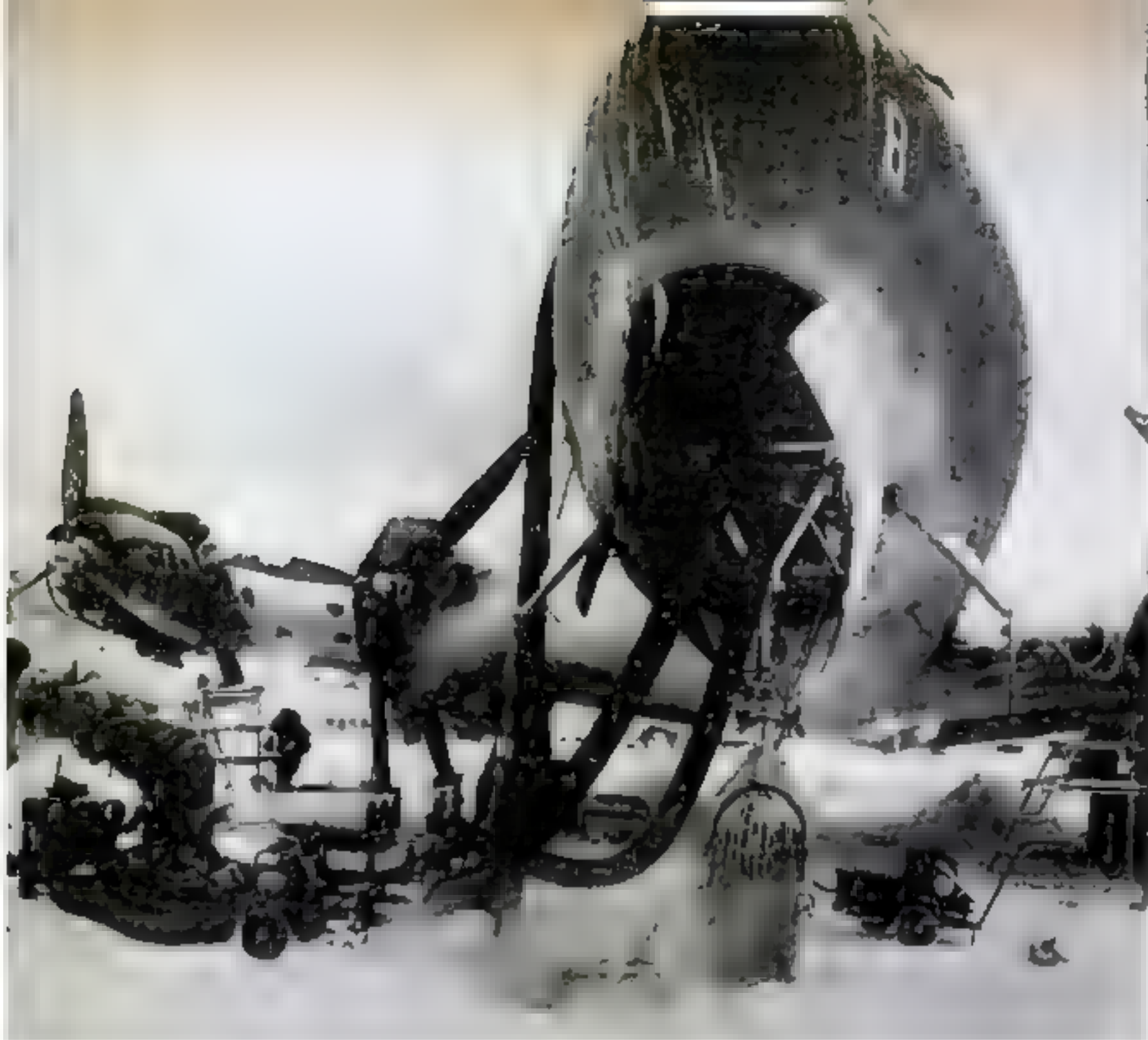
These giant self-propelled units are a combination of several devices in a single snow-eating machine. Whirling corkscrew blades on the front of the machine tear into the hard-packed windrows of snow, drawing the



Four feet of snow on the level is an average fall for arctic bases. Long-handled shovel shows depth.



Beneath this drift, crossed by the shadow of a telephone pole, lie trucks that must be shoveled out.



This Douglas C-54 of the ATC is being serviced in high winds and zero weather. Hoses pump hot air into ship to make interior bearable for workmen. Work areas around it are cleared of snow by men with shovels.

mass into a center maw where it is fed into a whirling vertical fan that hurls the snow 200 feet to one side.

This spreads the snow out, breaking down the windrows and dispersing them in a fine shower over the unplowed part of the area. By this time the scrapers and angle plows are back at the start again, pushing the snow farther back; then the process is repeated. The snow must be cleaned far beyond the edges of the runways, for high drifts and piles along the edges would endanger wing tips and cut down the usable width of the strip.

Runway boundary lights also must be uncovered. This is usually done by hand to prevent damage to glass reflectors and equipment. Tall painted poles are used to

mark the lights as soon as winter approaches, for sudden early-season storms might catch the snow-removal gang unprepared, and valuable time would be lost fishing for the lights in the giant drifts. Taxi strips and hangar aprons are cleared with the scrapers, angle plows, and "V" plows that have blades seven feet high and auxiliary blades that make them even higher. Much of the work about the hangars, on fuel tanks, pumps, and service areas, however, must be done with the old reliable hand shovel to save these installations from injury by the ponderous mechanized snow equipment.

Snow plowing begins before the snow starts piling up, to keep ahead of it, but when gales reach *(Continued on page 222)*

Your Pin-Up

RYAN FIREBALL—U. S. NAVY'S FIRST JET FIGHTER. First plane in the world to combine jet and reciprocating power plants, the Fireball has a 1,350-horsepower Wright Cyclone engine in the nose that does the pulling while a General Electric I-16 jet job in the fuselage boosts it from the rear. But the ship can streak along on either power plant alone—at 320 m.p.h. with the front engine and 300 m.p.h. with the jet unit. With both engines operating at full power it can climb at a mile-a-minute clip. The Fireball's armament consists of four .50 caliber machine guns, each fed by 300 rounds of ammunition. Also, two 1,000-pound bombs and racks for eight rockets may be installed under the plane's wings.







Work Held in Hydraulic Positioner Is Always Right Side Up

YOU tackle your task with both hands when a PowrArm holds your work. A mere twist of the hydraulic-pressure lock nut firmly locks the head and arm in any position desired. The head may be turned in a complete circle horizontally, and the arm, working on a ball and socket under hydraulic

pressure, may be moved in a 90-degree arc from horizontal to vertical. Adapters for holding work, such as the one clamped on the arm in the picture above, right, are removable, and special adapters are easily attached. The Garfield Engineering Co., Wichita, Kans., is the manufacturer.



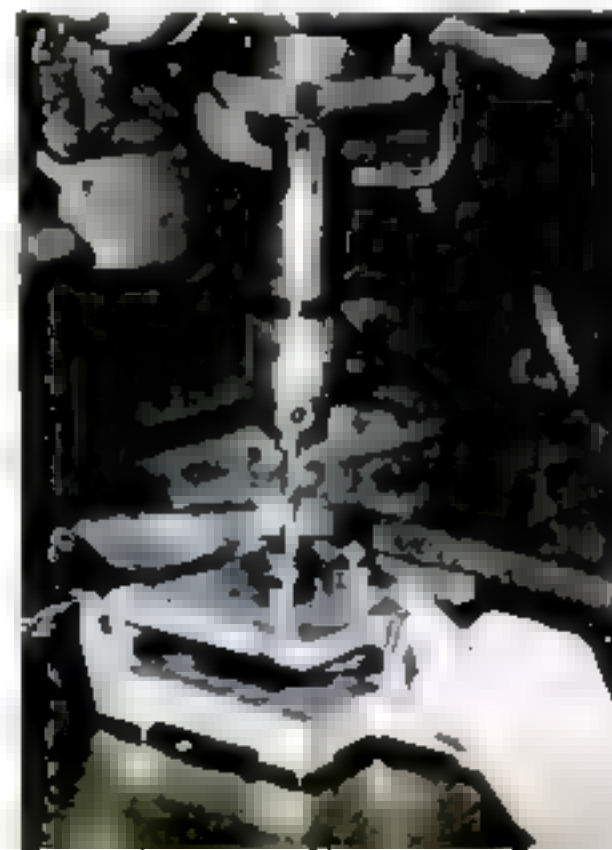
One-Handed Wrench Has Ton of Gripping Power

DESIGNED for one-hand operation and having more than a ton of gripping power in its steel jaws, the wrench on the left is as easy to use as a pair of pliers. The nut in the center regulates the width of the jaw opening. A red Tenite handle insert adds color to this product of the Botnik Motor Corp., Binghamton, N. Y.



Tumble-Latch Jig Speeds Operation on Drill Jobs

SPEED and precision in doing mass-production drill jobs are assured with the aluminum-alloy jig put out by the Oscar W. Hedstrom Corp., of Chicago. A tumble-spring-controlled latch aids in the fast operation, and locating pins and an adjustable clamping screw contribute to the exactness achieved in drilling the workpieces.



ID LIKE TO SEE THEM MAKE

Everybody has his own pet idea of some gadget he would like to see in general use. What is YOURS? Popular Science Monthly will pay five dollars for every such suggestion published.

"FITTED" BED, with spring strength proportioned to the weight of the prospective sleeper. Springs should also be adapted to the weight of the various parts of the body, so that the user will naturally lie in the correct position.



STRETCHABLE HOME. House plans for young couples should provide for the planned addition of more rooms as the family grows. Thus, young couples could start out with homes suited to their actual needs, instead of fettering themselves with debt for space they won't use right away.

HUM-FREE ELECTRIC FAN. It's hard enough to sleep on a hot night, without a noisy fan. Much progress has been made in reducing fan-motor noise, but nothing less than absolute silence will do.



CONVERTIBLE TABLE-CHAIR would be a space saver for apartment dwellers. The table top could be pivoted to swing over the back of a comfortable armchair, after the manner of Junior's high chair.

WRIST-WATCH ALARM. So you have trouble getting up in the morning? What you need is a wrist watch with an alarm in the form of a pin that will give you a jab when it's time to pry yourself loose from the mattress. For persistent dozers-off, a repeat action can be added to keep up the prodding until the desired effect is produced. Especially recommended for people who simply ignore alarm clocks. Some bright inventor has probably patented this idea already. Let's have it!





The dragon-faced torch-fish lives half a mile deep, and his torch emits cold silvery light with bluish-purple reflections. Dr. Beebe caught the only two ever taken.

"IN THE DEEP BOSOM
OF THE OCEAN BURIED"

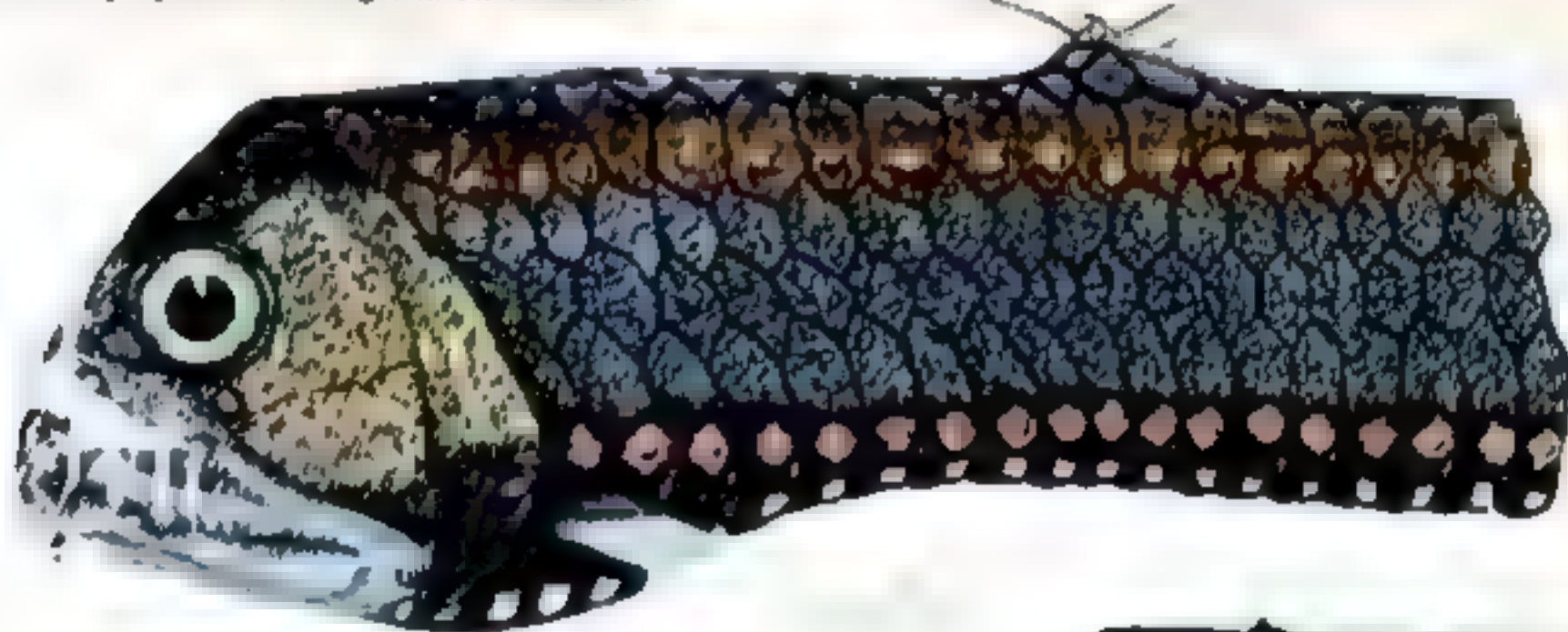
STRANGE FISH FOUND AT GREAT DEPTHS

Dr. William Beebe, Undersea Expert, Brings 'Em Back—but Not Alive

THESE hitherto unpublished pictures had to be sketched by artists at top speed to catch the true colors while the creatures were still alive. Since the fish are netted far below the surface off Bermuda, many do not live more than 10 minutes after de-

pressurization at sea level. They are brought up in a silk bolting-cloth net about 30 feet long and three feet across. They are immediately placed in an aquarium filled with ice-cold salt water, and the artist gets busy recording their strange shapes and colors.

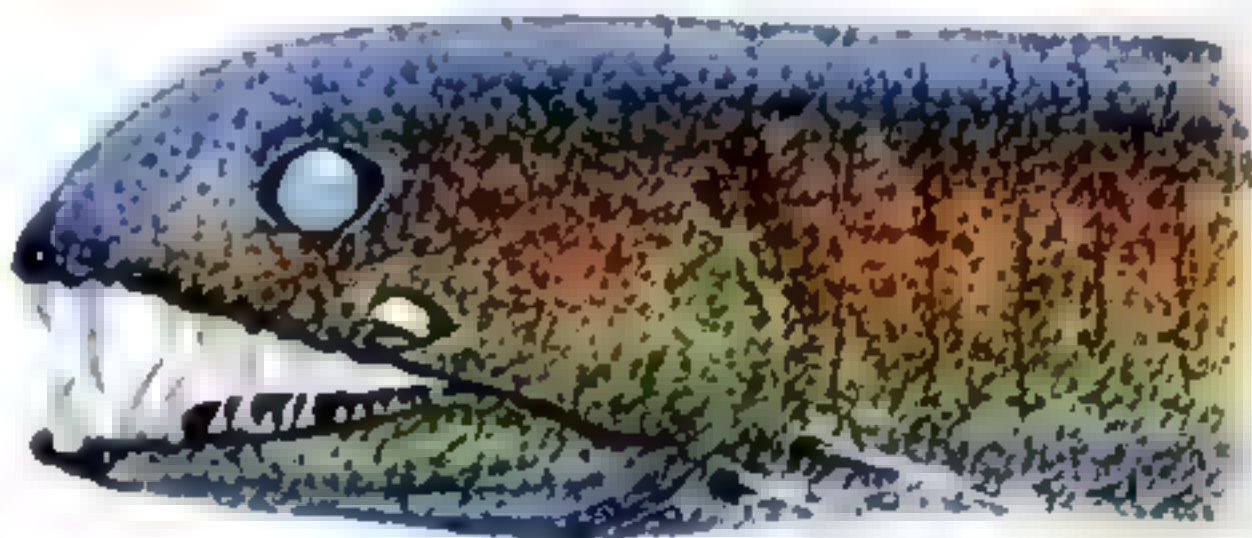
Sober-toothed viperfish has such long fangs that he can't shut his mouth. A slender tentacle feels for prey and for danger in all directions.



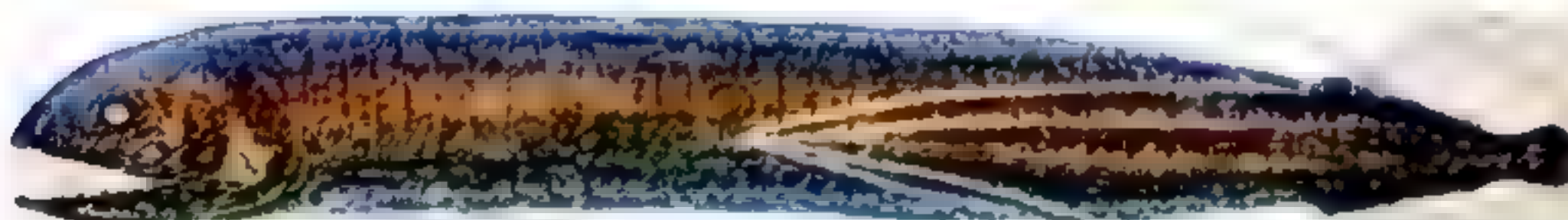
There's no name yet for this yellow-green angler fish with an enormous mouth always ready to engulf the prey attracted by its luminous lure. Tentacle-covered skin warns of any movement in the water surrounding it.



Scientific name means "metallic lover of the deep." A mile down its colored lights glisten with tremendous power. It feeds on fish almost as big as itself and uses its fins as tentacles.



Paintings by Elso Bostelmann and Helen Tee-Van from New York Zoological Society



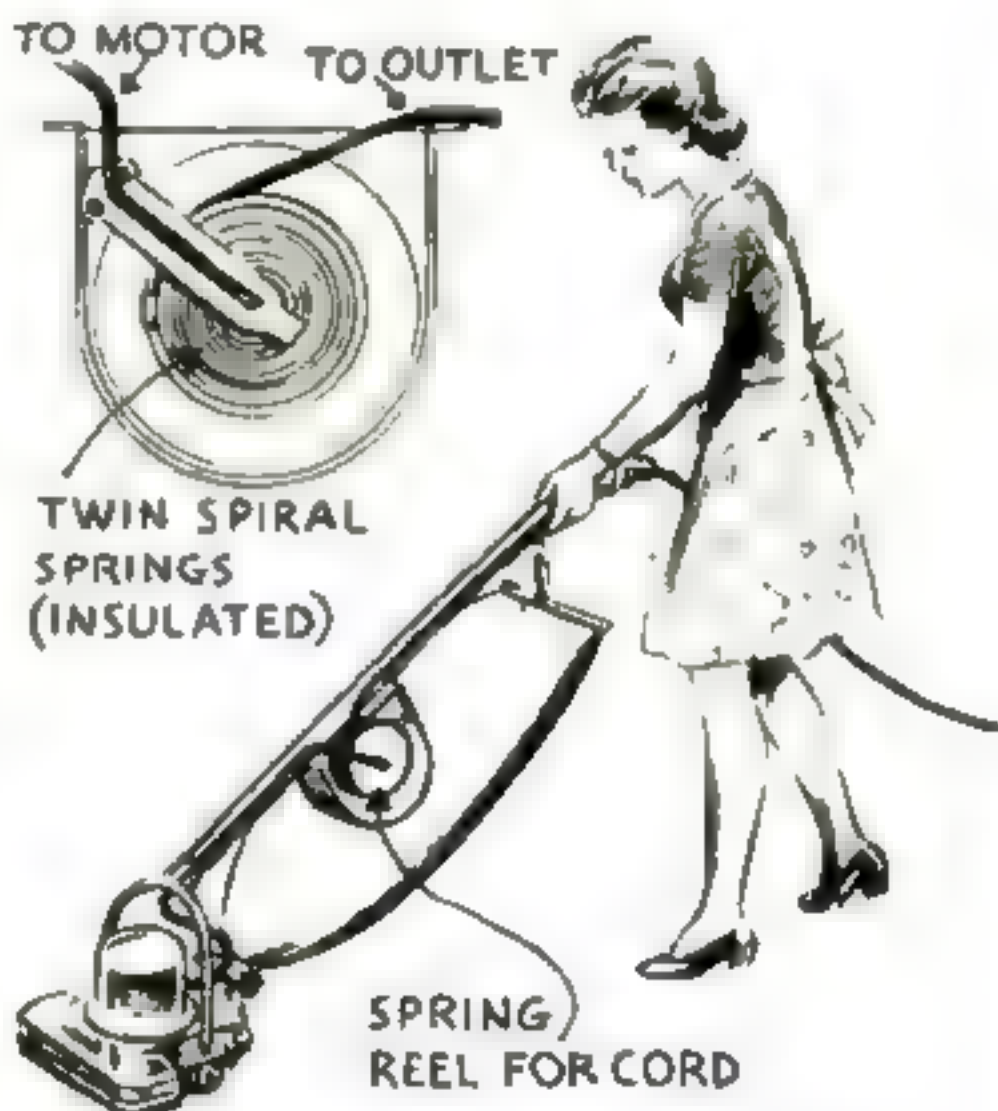
SCREW TOP
HOLDS FLOSS



TURN KNOB
TO TIGHTEN

REMOVING FOOD PARTICLES stuck between the teeth is made easy with the dental-floss holder and applicator invented by Arthur L. Peterson, of Long Beach, Calif. To make the device ready for use, a container of floss is inserted in the hollow handle. A length of the thread is then drawn out, and the bottle cap screwed on to secure that end. The extended thread is now laid in the grooves of the arms and brought around to the end opposite the bottle top. Here it is made fast in the slit of a tensioning knob, which is turned to tighten the thread.

YOU WON'T TRIP on the electric cord of your vacuum cleaner, nor will the cord become snagged around legs of furniture, if the cleaner is provided with a reel that feeds out cord through the hollow handle as you move away from the outlet. The cord automatically winds back on the reel unless braked by a control button on the upper end of the handle. Devised by Donald H. Reeves, of Dayton, Ohio, the reel does not increase the size of the cleaner because it is mounted on the underside of the handle, with the dust bag specially fitted to cover it. In fact, less space is required for storage since the hooks for holding the cord are eliminated.



COMBINATION KIT BAG AND STOOL at the left is spacious enough to hold much equipment and comfortable to use as a seat when the frame is spread apart. Inventor Edward S. Reid, of Charlotte, N. C., claims it is an exceptionally handy stool for hunters who wait for long periods of time in duck blinds or in fields. Gardeners, picnickers, and nurses will also find it useful. The kit portion contains sizable separate pockets that will accommodate shotgun shells, game, food, and other things. Strips of metal or wood form the frame, and fabric or leather, or a combination of both, is used to make the kit. Light in weight, the seat-bag is easily carried by the grips when the frame is collapsed.



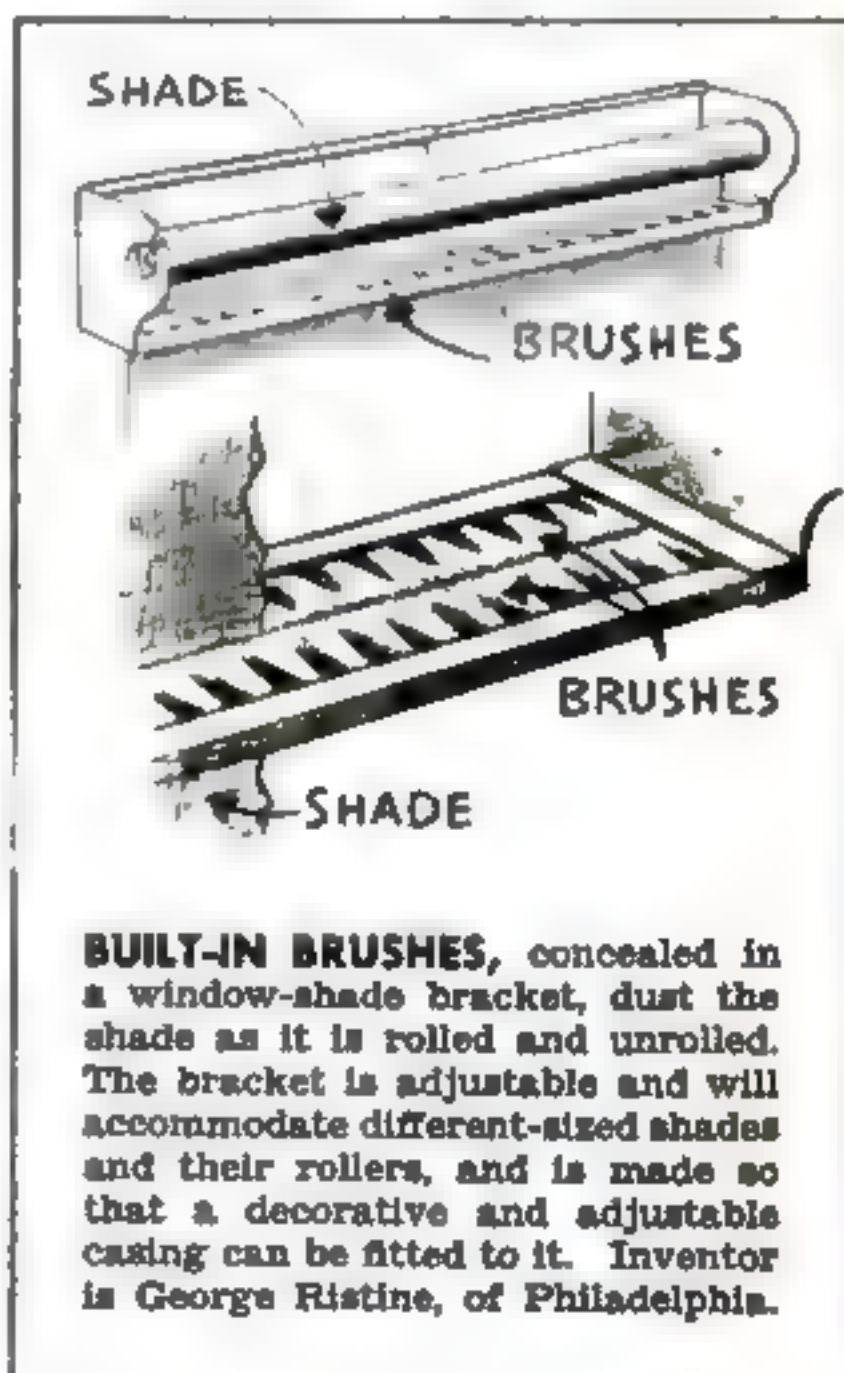
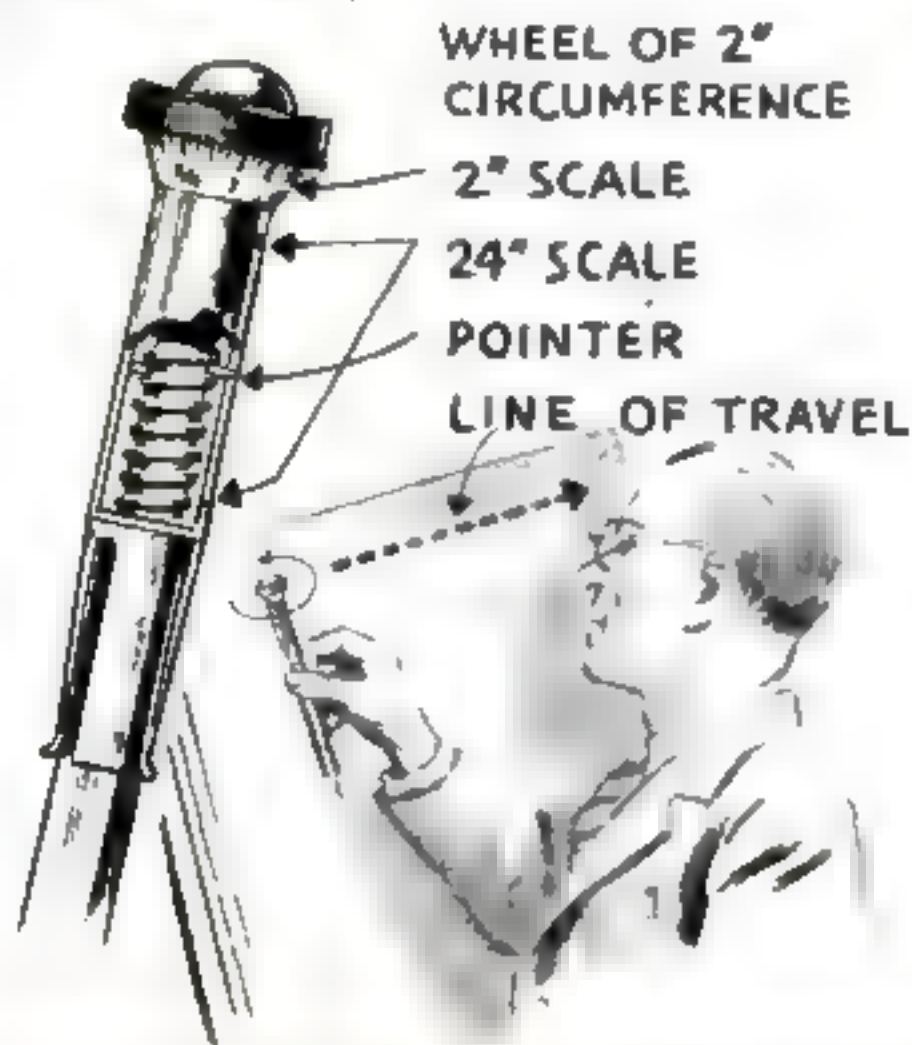
FOLDED

THE INVENTORS

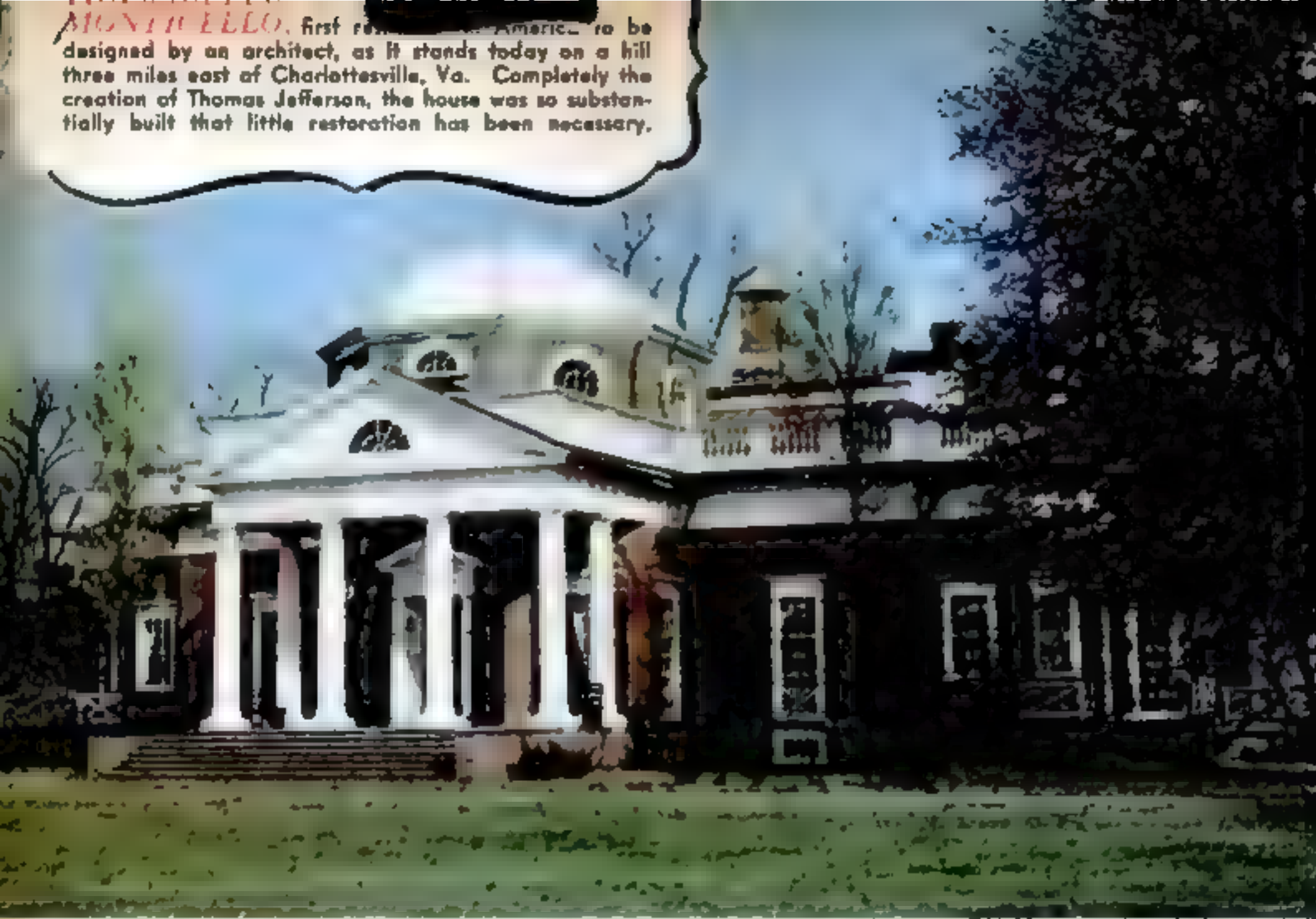
FIRE-EXTINGUISHING BOMB, the opposite of the wartime incendiary bomb, enables fire fighters to attack forest fires and prairie fires from the air. Developed by L. W. Moore, of Baltimore, Md., the missile contains an explosive powder that is detonated when the striking pin hits the ground or when the firing ring comes in contact with any object in the burning area. The resulting explosion scatters a fire-extinguishing chemical on the fire and the surrounding area. The winged tail assembly causes the bomb to fall nose first and hit the ground on its detonating pin.



ROLLER RULE for quickly measuring distances and dimensions fits snugly over the end of a pencil, as shown below, or a fountain pen. Pressure on the rotating wheel as it moves across a surface turns a screw inside the barrel that moves an indicator along a 24-inch scale on the outside. One complete turn of the wheel measures two inches. J. H. Morshead, Long Beach, Calif., is the inventor.



MONTICELLO, first residence of America, to be designed by an architect, as it stands today on a hill three miles east of Charlottesville, Va. Completely the creation of Thomas Jefferson, the house was so substantially built that little restoration has been necessary.



POPULAR SCIENCE TRACKS DOWN THE TRUE STORY OF

Thomas Jefferson's Inventions

**AUTHOR OF THE DECLARATION OF INDEPENDENCE
ALSO BELIEVED IN EMANCIPATING MEN FROM
ANY UNNECESSARY DISCOMFORT AND DRUDGERY**



By
GOLD V. SANDERS
Photographs by
WILLIAM W. MORRIS

IF HE did not have so many other claims to fame, Thomas Jefferson might today be celebrated as one of our greatest inventors. His mind fairly overflowed with mechanical ideas, and the fruit of his creativeness is everywhere in evidence. Had he not been so preoccupied with an even bigger job—creating a new government for a new nation—

he might well have been the great scientist of his age.

Every plow that turns the soil is a better tool because of Jefferson. Never satisfied with time-honored methods in any field, he devised a moldboard based on the principle of least resistance, one that would turn the sod over instead of merely lifting and dropping it. That principle is embodied in all plows today.

A large-scale farmer all his life, Jefferson introduced the idea of contour plowing when he saw his hilly plantation being ruined by erosion. Sound as his idea was, it is only

150 YEARS AGO, when a colonial miss opened one of the double doors on the first floor of Monticello, the other door swung open automatically with it, thanks to mechanism installed by Jefferson and still concealed in the paneling. This miss of today finds the doors still working perfectly, except for a play in the action due to decades of use.







STREAMLINED IN CONTOUR, Jefferson's "improved moldboard for a plow" was designed to follow the lines of the least resistance in turning the sod. Its principle is used in plows today.

ONE OF FIRST in existence. If not the first, the dumb-waiter installed in Monticello by Jefferson was designed to deliver wine to the dining room from the cellar. It is concealed by a panel door in the side of the mantel when not in use.



THE WEATHER VANE on the east portico is like others of its time—with a difference. Jefferson brought the shaft down through the roof to the ceiling of the porch, where he placed a dial, shown in photo below. Thus it was possible for him to learn the wind's direction without leaving the house.



in comparatively recent years that it has really taken hold throughout this country.

Jefferson believed the everyday chores of life consumed too much time, and he created numerous devices to simplify these tasks. Many of his inventions are preserved in his famous home, Monticello, in Virginia. Others are known only from notes, drawings, or reports. When he built his home, he installed a dumb-waiter, possibly the first, to send up wine from cellar to dining room.

Atop the east portico is a weather vane, much like others of the time, but Jefferson brought the shaft all the way through to the porch ceiling and placed a dial there so that one could see which way the wind was blowing without going outside.

There is an immense clock in the drawing room, built by a Swiss to Jefferson's design, which tells the day of the week as well as the hour. Cannon balls on ropes provide the motive power for the hands and gong. It is wound once weekly by a long crank. The days are inscribed on the wall where the balls pass them in slow, gradual descent. Since a servant had to climb a



JEFFERSON'S INGENUITY is nowhere better exemplified than by this clock, built to his plans by a Swiss clockmaker. It was operated by two sets of cannon balls, whose slow descent also marked the passage of the days. Jefferson also designed a folding ladder for the man who wound the clock.

ladder to wind this clock, Jefferson devised a folding ladder of unique design for that purpose. It is still at Monticello.

Between the two great rooms on the first floor are double doors provided with an ingenious apparatus hidden behind the paneling which causes both to open or close in unison. No one seems to know how it works, as the paneling has never been removed.

Monticello, incidentally, was the first residence in America built by an architect. Jefferson was that architect and today is recognized as a very great one.

It is believed Jefferson had ideas on air conditioning. Only this can account for the elaborate air shaft built of stone which runs from below the hill at Monticello into the basement of the house. How well it worked is not recorded; the inside end was sealed some years ago.

Not only did Jefferson improvise, but he was quick to adopt new ideas wherever he

found them. To this trait we owe the swivel chair, which he discovered in France. He had at least two revolving chairs made by his skilled slaves. (Although he owned slaves, Jefferson was opposed to the idea of slavery.) One chair is still there and another is preserved by the American Philosophical Society in Philadelphia. The second has an added Jeffersonian touch, a writing arm.

One of the statesman's own inventions, important in its time, was the portable copying press, a simplification of the customary screw press. His drawing for this, with its meticulous lettering and description, is preserved by the Massachusetts Historical Society.

Jefferson never applied for a patent. He made sketches of an invention primarily for the use of the workman who was to produce it. There is no record of his having ever made anything with his own hands. When he found an invention useful, he often



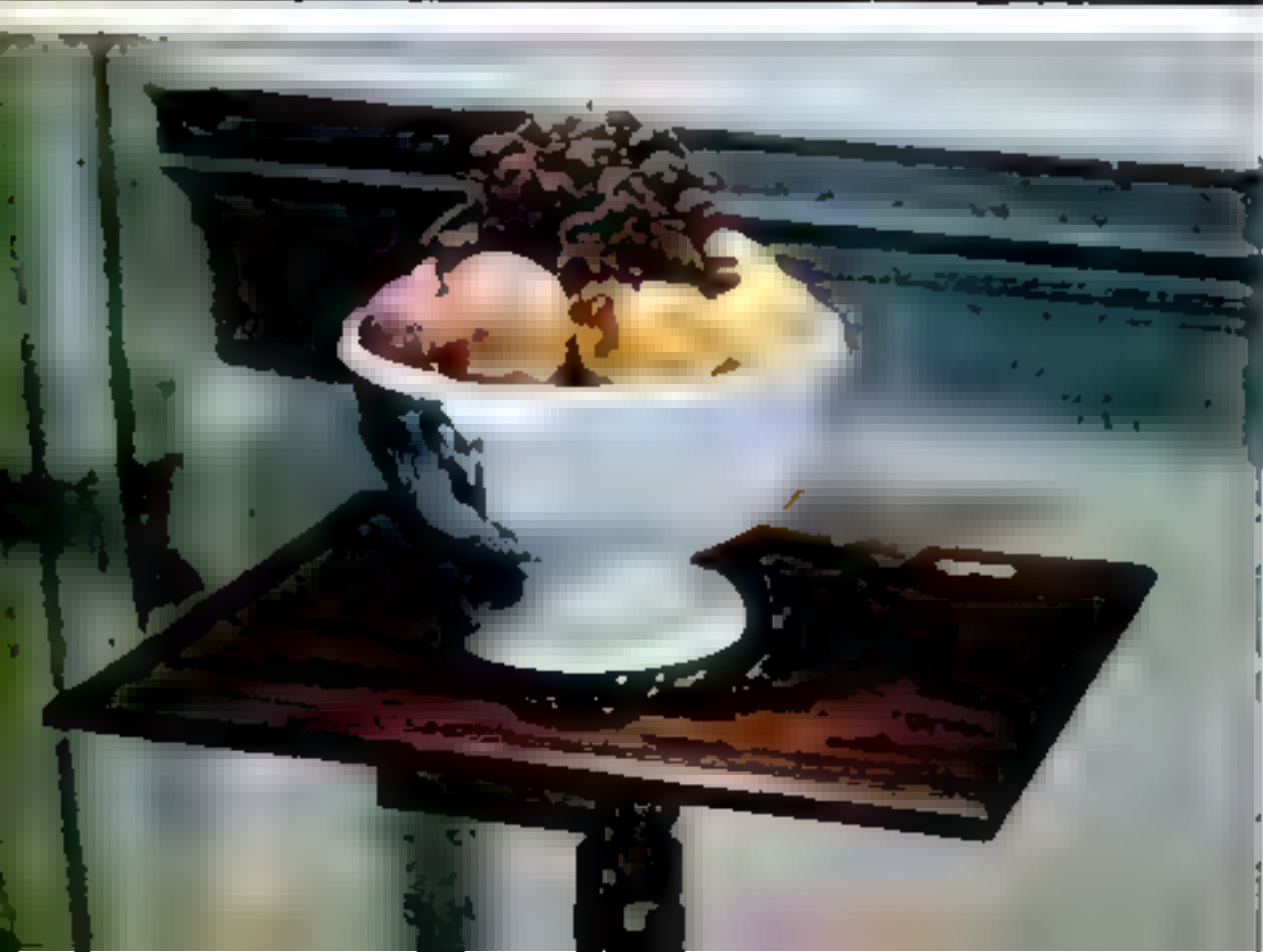
MUSIC STAND. Jefferson, an accomplished violinist, stood many hours before this stand, practicing on his favorite instrument. The slope of the music rack is adjustable, as the photo above shows. In addition, the rack could be lowered and thus converted into a table (see photo below). This stand is believed to have been made by a skilled artisan among Jefferson's slaves at Monticello.



made careful specifications which he sent to friends. He apparently never thought of inventing for profit.

Jefferson abandoned the copying press when he discovered the polygraph, invented by another. Of this instrument he wrote a friend in France, Count C. F. C. de Volney, as follows:

"Our countrymen are so much occupied in the busy scenes of life, that they have little time to write or invent. A good invention here, therefore, is such a rarity as it is lawful to offer the acceptance of a friend. A Mr. Hawkins, of Frankford, near Philadelphia, has invented a machine which he calls a polygraph, and which carries two, three, or four pens. That of two pens, with which I am now writing, is best; and is so per-



THE MUSIC hour ended, the rack becomes a low decorative table.



ONE STAND—FOUR PLAYERS. Another of Jefferson's ingenious devices was this music stand, with adjustable racks for four players. The stand itself revolved atop the cabinet where it was placed. The cabinet was used to store music and still contains some of Jefferson's own. It is now at Monticello



PHOTOGRAPHIC PRINCIPLES intrigued Jefferson. His camera obscura could not, of course, take pictures. It reflected an image on ground glass at the back and this could be traced on tissue paper.

fect that I have laid aside the copying press, for a twelvemonth past, and write always with the polygraph. I have directed one to be made, of which I ask your acceptance . . ."

The portable writing desk on which he penned the Declaration of Independence was a neat contrivance which Jefferson designed himself, but which was made for him by a Philadelphia cabinetmaker. Its tilting, adjustable writing top must have served him well, for he later had two larger desks made, with similar features, at Monticello. One is an architect's desk at which he stood, pre-



THIS ODOMETER was attached to the hub of the wheel of Jefferson's carriage. The hand moved a notch with each revolution, tallying distance traveled. Jefferson's notes say he bought it for \$10.

sumably, while designing such notable buildings as the University of Virginia, the state capitol of Virginia, the home of James Monroe, near Monticello, and mansions for other

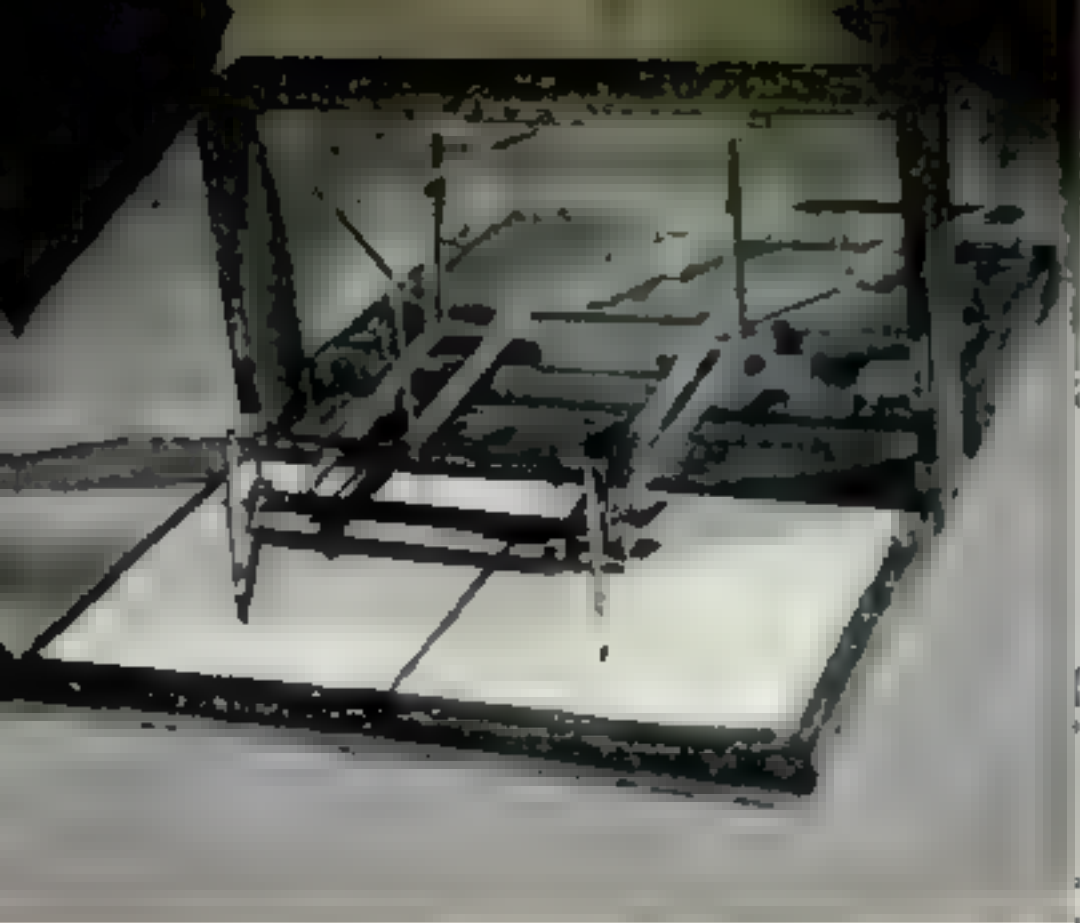
For the home of one friend, Jefferson provided a sort of "lazy Susan," installed in the wall between dining room and pantry and revolving so that food could be sent in by turning it about.

Jefferson was the first, after Benjamin Franklin, to make use of bifocal spectacles. Seeing the ingenious doctor making good use of them, Jefferson sent his optician in Phila-



THIS HE BORROWED FROM THE FRENCH.

Thomas Jefferson has often been credited with the invention of the revolving chair; actually he was the first to introduce it into this country after bringing one from France. Chair in photo, although of the revolving type, does not swing freely Jefferson used it in conjunction with a padded bench, on which he stretched his legs while writing, and a table with a revolving top, believed to have been made to his design at Monticello. It was here, undoubtedly, that Jefferson conducted much of the voluminous correspondence of later years.

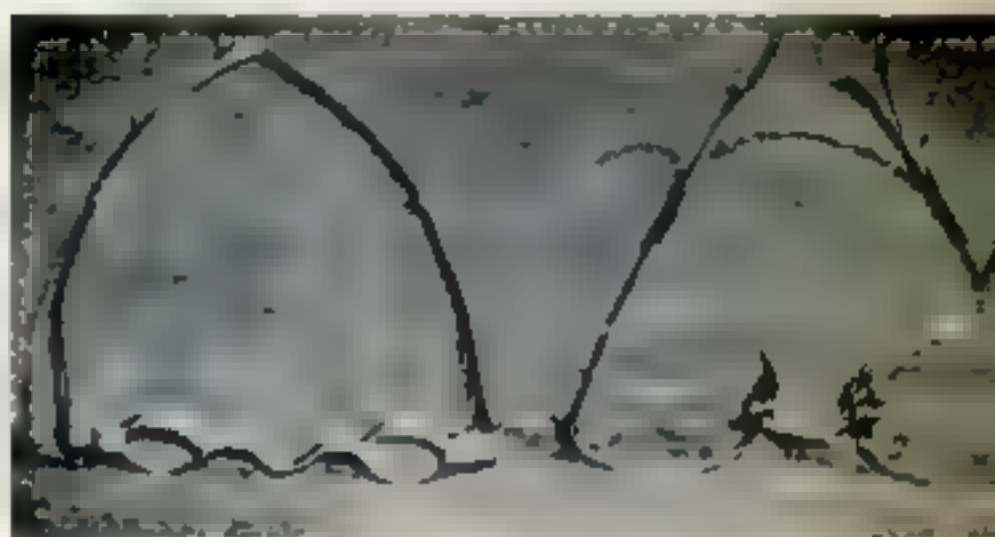


DECLARATION OF INDEPENDENCE was written by Jefferson on this portable writing desk of his own design. The desk has a folding and tilting top and a small drawer for writing material.

THE POLYGRAPH so impressed Jefferson that he used it in preference to a copying press of his own invention. As Jefferson made copies of all his letters, the dual-pen device proved invaluable.

delphia a drawing of Franklin's and ordered a similar pair, with a set of semicircular lenses of different strength

There is no way of knowing how many gadgets Jefferson invented. In bits of correspondence it is revealed that he devised a new kind of flax beater. He had a convenient contrivance near his bed for hanging up clothes and a machine for measuring strength. Edmund Bacon, his overseer for 20 years at Monticello, said Jefferson was forever busy with some design or model. Bacon declared Jefferson was the first to introduce full-blooded Merino sheep and Cal-



SPECTACLES worn by Jefferson are shown next to a modern pair. Small lenses were for reading and he looked over them for far vision. Jefferson sent minute instructions and drawings to his optician,



ARCHITECT'S TABLE. At this desk were conceived some of the most beautiful buildings in America. Here again Jefferson laid heavy stress on convenience. The drawer has a special pair of legs to support it when it is drawn out, as shown in the photo at the right. The top of the drawer can be made to slide back and forth (photo at the left), thus serving as an auxiliary table. Photo in the center shows the back of the tilting top, and the notches permitting it to be set at various angles.





FILING TABLE. Jefferson not only invented many useful objects; he was quick to adopt the innovations of others. He bought this filing table, now on display at Monticello, in England. It has eight compartments for filing papers, three letters for each drawer. For unknown reasons, Jefferson eliminated the letters J and V from his filing system. In order to fit under the eight-sided table, the drawers had to be alternately triangular and quadrangular. Drawing at right shows how they nested under the top. There is an ingenious locking device on the table that may or may not have been of Jefferson's design. The entire table top can revolve.



HIS COOLING SYSTEM?

Air conditioning à la Jefferson. This is the vine-covered entrance to a stone shaft, some 300 feet in length, that leads from a point below the hill at Monticello into the cellar of the old mansion. The belief is that Jefferson intended it for air-circulation purposes, to cool the house in summer, but no mention of it has been found in the statesman's records. The basement terminus of the tunnel was sealed off many years ago.



SOLID STUFF. The bricks, made of native red clay, and the mortar, prepared under Jefferson's supervision, were of amazing durability. Today, despite 175 years of exposure, they look almost new.

DINING-ROOM MANTEL at Monticello is admired by a modern miss in an early nineteenth-century costume. The mantel insert, made by Josiah Wedgwood, well-known English potter, was picked up in London by Jefferson. The clock was purchased in Paris. Both are characteristic possessions of Jefferson, who was constantly in search of the beautiful as well as the useful in all things.

cutta hogs to Virginia. Both were improvements over existing breeds, and Jefferson provided blooded sires for the whole countryside.

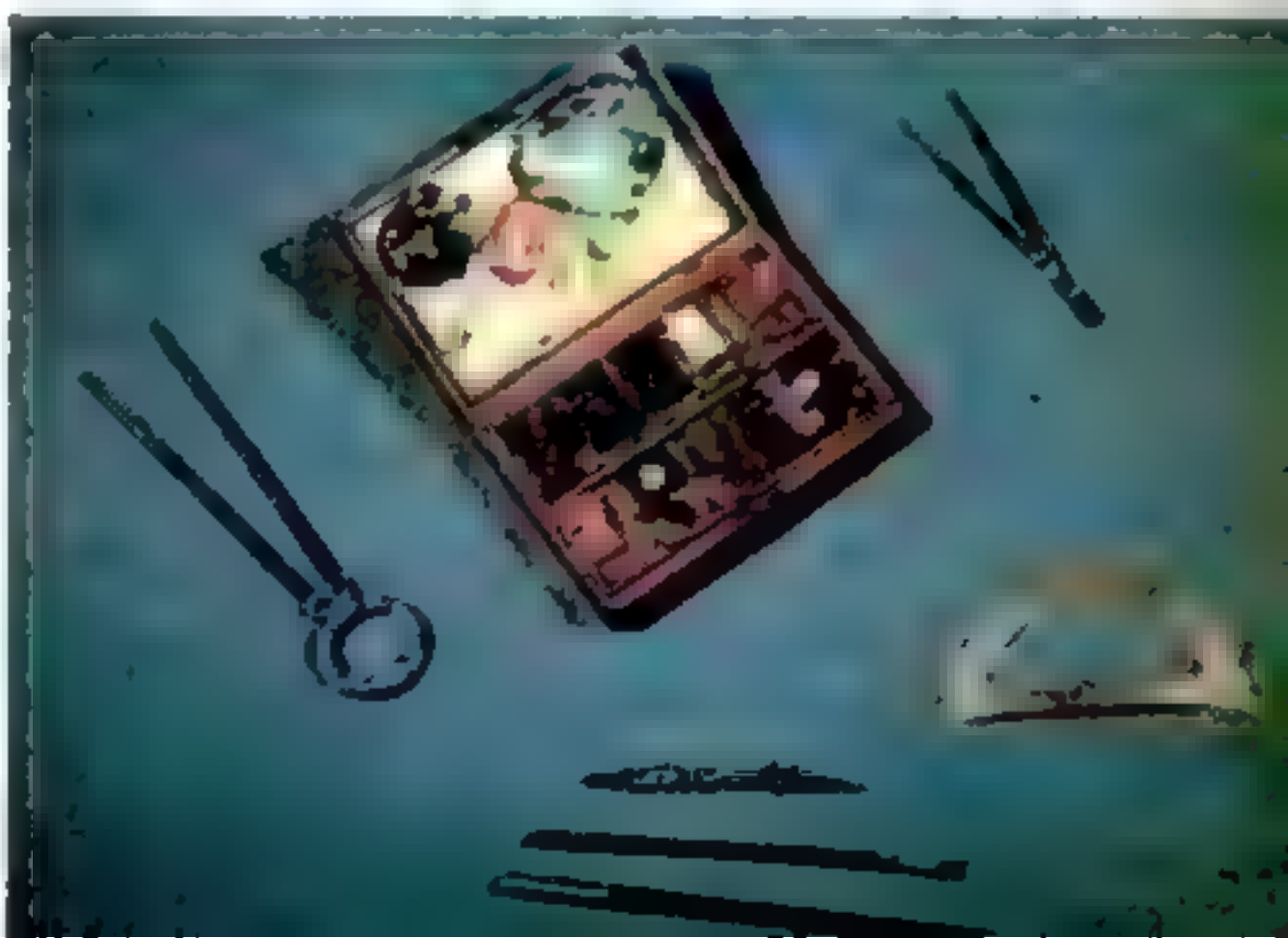
Jefferson also introduced countless crops, fruits, trees, and decorative plants from Europe and from other sections of America. When these flourished in Virginia, he furnished seeds, cuttings, and seedlings generously to friends. His experiments with imported olive trees were without success, however.

Jefferson was virtually the father of the

U. S. Bureau of Standards, but tried in vain to gain the adoption of a decimal system of weights and measures by the Government. If his will had prevailed, we would not be plagued today with the intricate, unsystematic hodgepodge still in use.

In every field Jefferson was the innovator, the experimenter, the inventor. The same zeal with which he pursued the struggle for liberty of men's souls actuated him in a constant search for means of improving the physical well-being and comfort of his fellow man in everyday life.

JEFFERSON'S TOOLS. The point box and drafting instruments with which the Sage of Monticello drew designs for his numberless gadgets, magnificent buildings, gardens, roads, fences, mills, and machines. As Jefferson was not himself adept at handwork, he drew up meticulous plans for others to follow. He designed the buildings for the University of Virginia, which he helped found in 1817. Jefferson also directed the academic development of the school.



BEST NAVY PHOTOS OF THE WAR

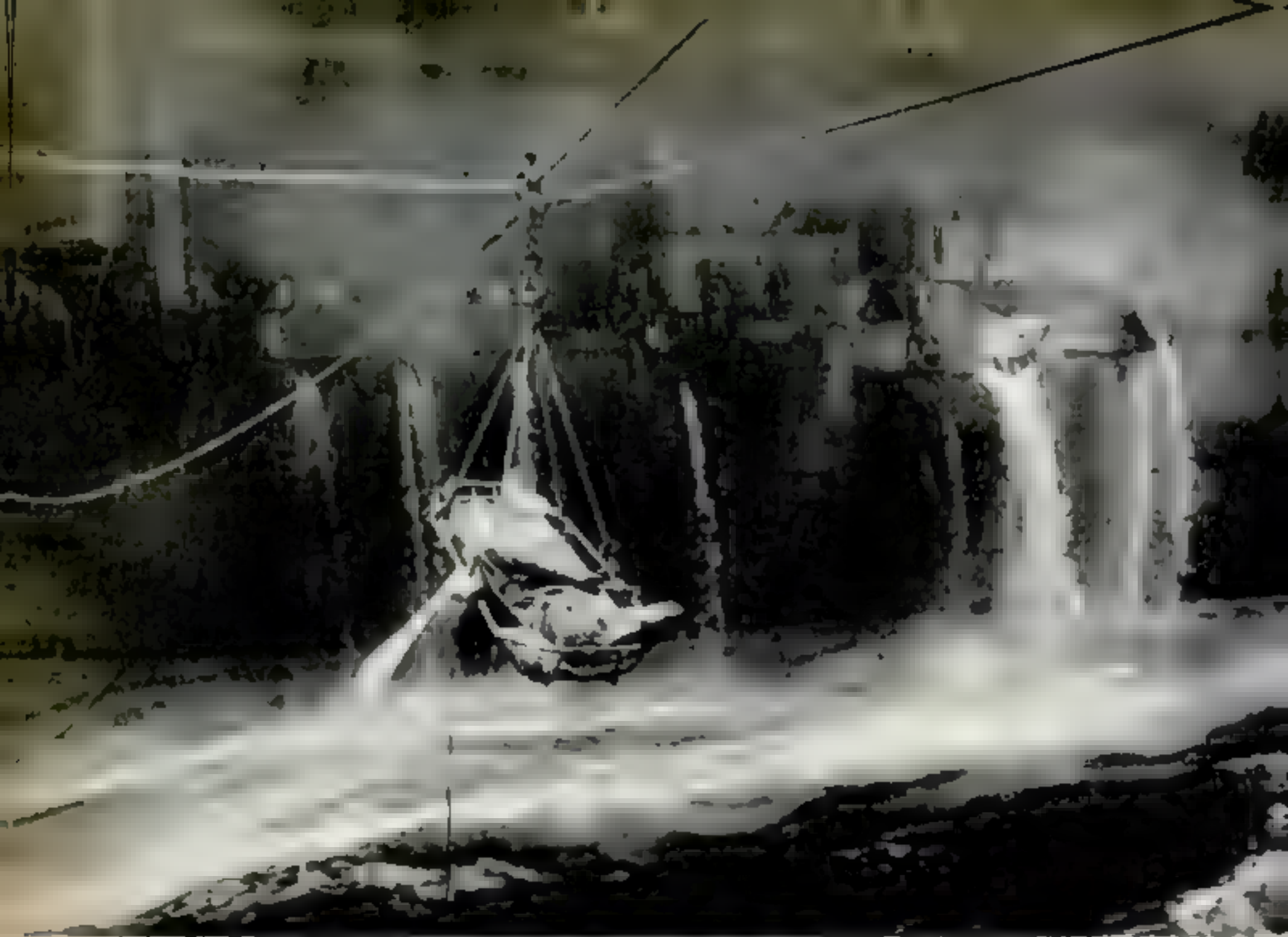
WHILE the U. S. Navy, Marine Corps, and Coast Guard were helping to hammer the Germans and Japs into submission, their photographers in uniform were busy preserving on film the dramatic story of the greatest war in history. The result is a pictorial record of inestimable value to both naval experts and civilians. From this album of battle Capt. Edward Steichen, director of the U. S. Navy Photographic Institute, selected the hundred best pictures for exhibition to the public. On this and the five following pages Popular Science Monthly presents nine outstanding prints that combine high photographic quality with the vivid reporting of history in the making.

ROCKETS AT OKINAWA. LSM(R)'s send up volleys of projectiles to clear the way for landings.





END OF A JAP. An enemy torpedo plane goes down in flames after receiving a direct hit from carrier anti-aircraft guns in operations near Saipan.



TRANSFER AT SEA. A wounded man goes over the side of the Bunker Hill to a waiting cruiser.

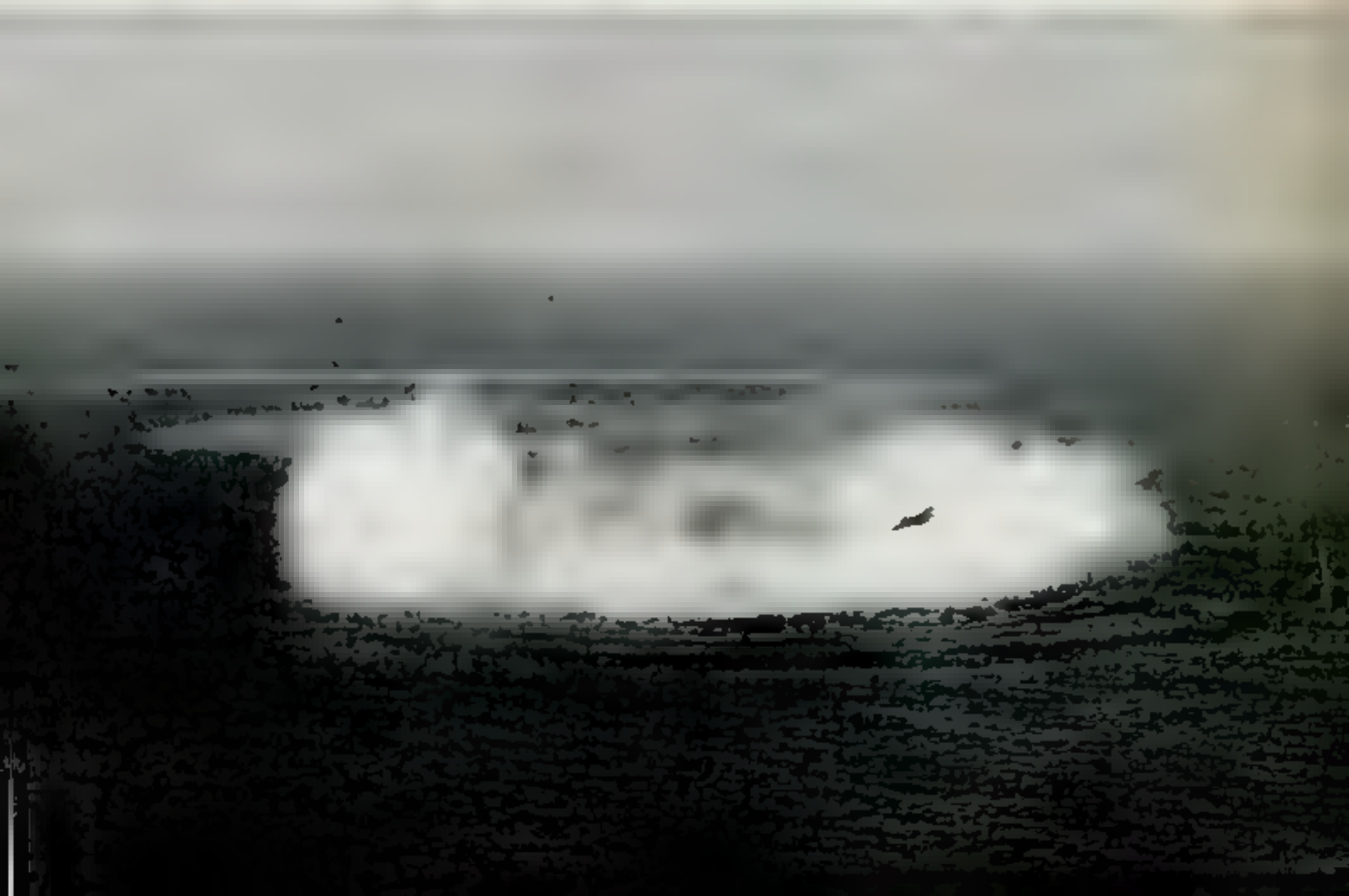
PACIFIC BATTLE. The Enterprise a destroyer and the South Dakota fight Japs at Santa Cruz.

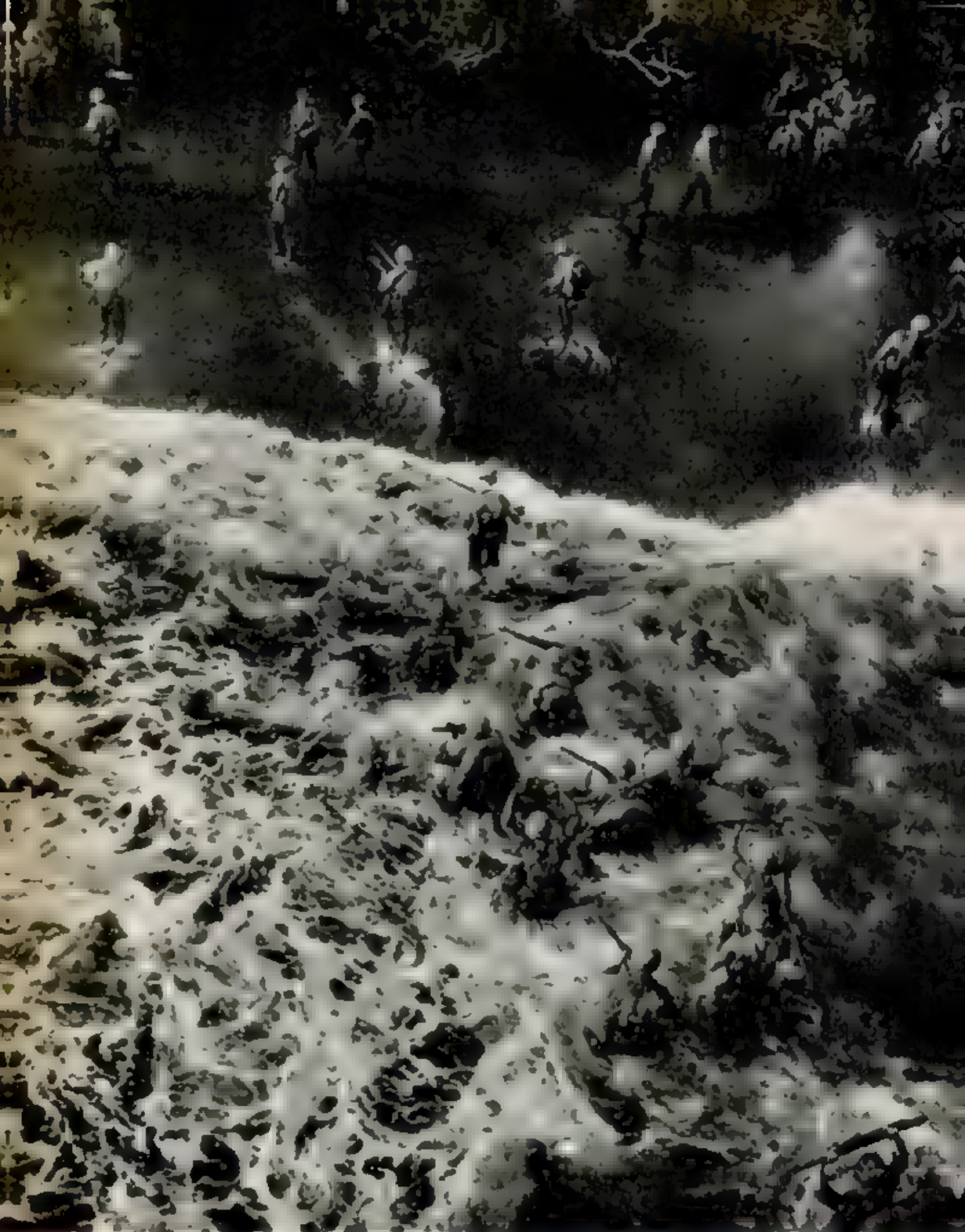




END OF A U-BOAT. Nazi sailors hug the conning tower of a submarine under attack by planes.

THE KILL. A U.S. plane circles above the oil slick that marks the grave of another "scratched" sub.





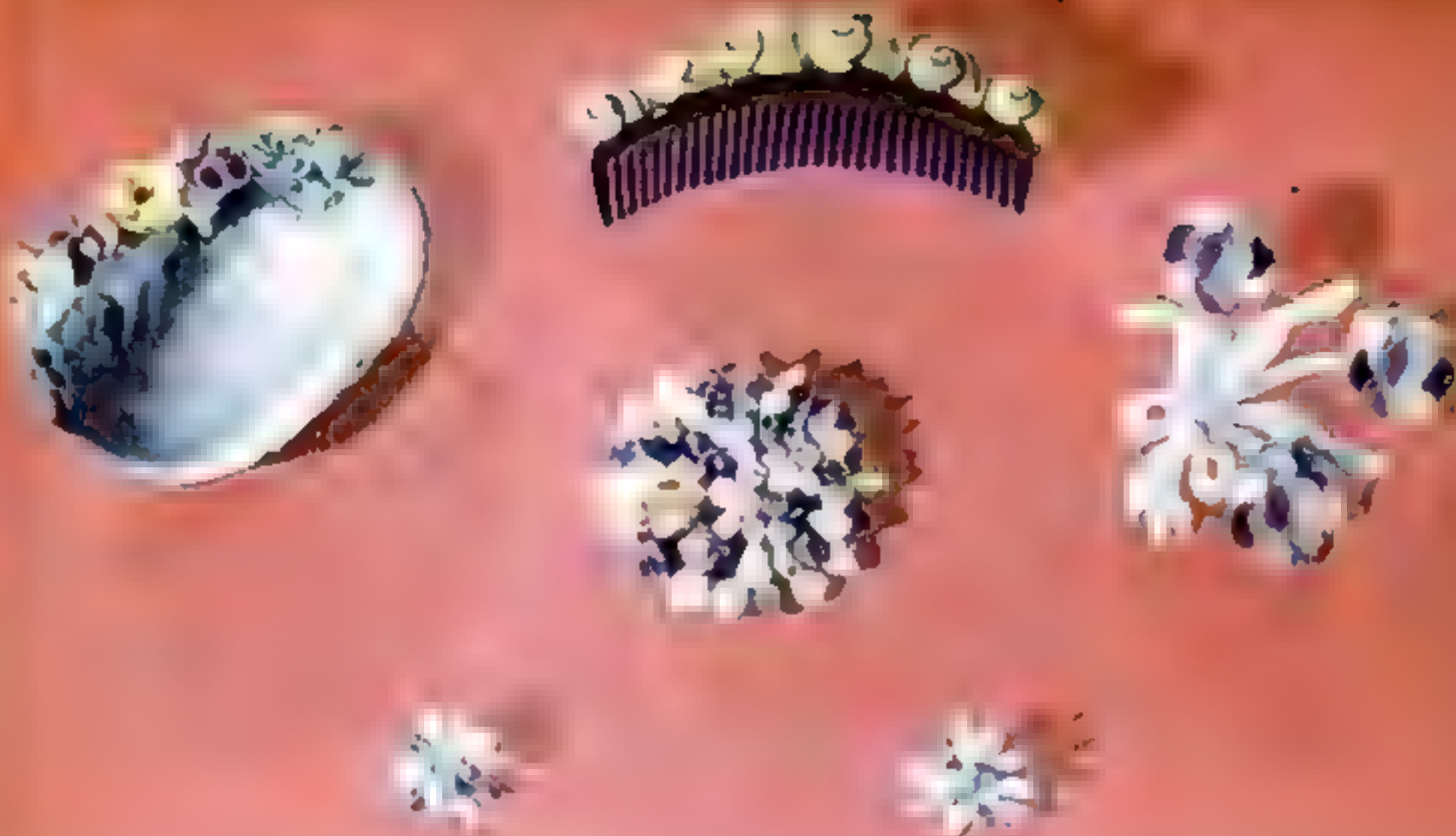
WADING IN. Carrying their rifles high, U.S. Marines plow through the surf for the landing at Cape Gloucester on New Britain. This remarkable shot captures all the drama and suspense of hitting the beach



ASSISTED TAKE-OFF. Rockets attached to the fuselage tick a heavy Martin Mariner into the air.

A LETTER HOME. Enlisted men relax in the crew's quarters of the famous carrier U.S.S. Yorktown.





Personal Ornaments Fashioned from Colorful Sea Shells

FOR centuries man made his knives out of sharpened shells. His first coins were shells. The first jewelry was also shells—shell necklaces and shell earrings. And now this ancient industry is staging a revival as a colorful hobby.

The cost of materials is negligible. A trip to the seashore, or a look through the children's box of mementos from that trip

last summer, will supply you with enough shells for fashioning many small ornamental objects. From shells you can make earrings, pins, ash trays, miniature flowerpots, and even dainty tea sets.

All you will need besides the shells are a few plastic findings and a tube of liquid cement. For detailed methods of construction, turn to page 156.

Puffing Iron Horse Decorates Wooden Fireplace Bucket

DRAW though the life of our ancestors may have been in many respects, they used color whenever possible in their homes. Tole ware, painted trays, hooked rugs, and other housewares showed abundant use of color, as did the embellished carriages of the rich. Much of the ornamentation that has come down to us is of a simple, almost childlike sort, yet pleasing and refreshing. It is an art of the people, naïve yet genuine in its own right.

Such a decoration, original but in the spirit of that earlier day, is shown on the fireplace bucket at left. It is done by a simple means of transferring a design on ruled squares and is finished in color enamels, as described on page 161. The design is appropriate also on a fireplace screen or tray, or it can be woven into a rug.





Hard-working passenger elevators pile up enormous mileages. In New York City alone, they travel daily a distance equivalent to 13 trips through the earth, lifting and lowering more than 10,000,000 people.

VERTICAL RAILROADS

**Their Traffic System Protects Millions of
Passengers Going Millions of Miles a Day.**

By FRANK ROWSOME, JR.

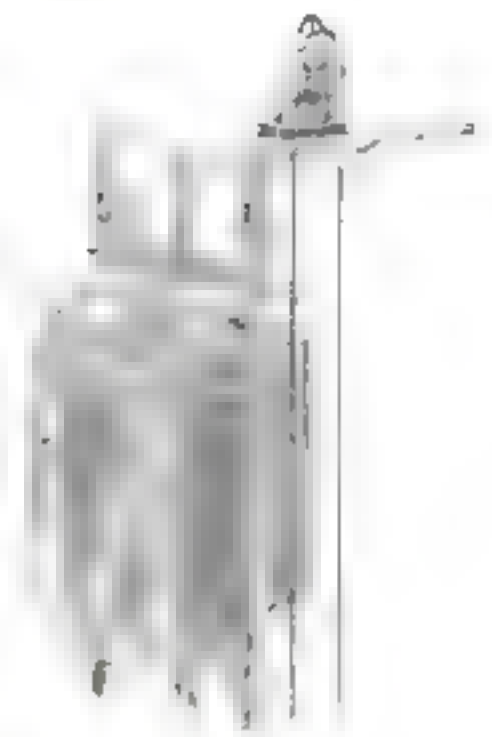
AMERICA has a transportation system which, in New York City alone, carries four times as many passengers every day as all Class I railroads. Ten million people a day are lifted or lowered 85,000 miles by New York's elevators. These short-haul, indoor, vertical railroads—most appreciated when stopped by a strike—have added a new dimension to our cities. Without them, few buildings would be more than 60 feet high because people display a marked reluctance to climb more than five flights of stairs.

Barring such events as a bomber going through a building and cutting both the

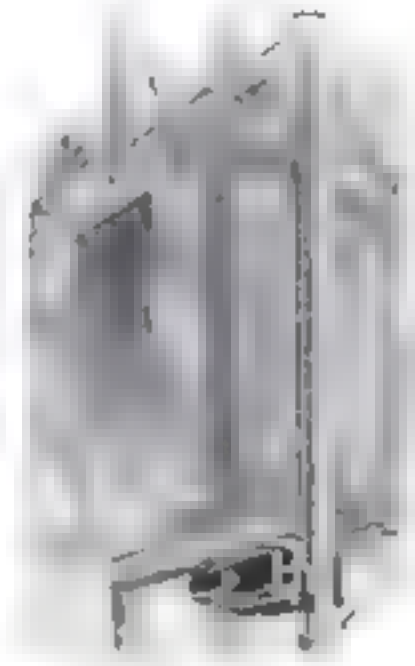
hoisting cables and the governor cables, accidents are rare. Cables are made from five to fifteen times stronger than they need be to carry maximum loads, and modern elevators have elaborate mechanical and electrical safeguards against all predictable hazards.

Each time a car moves, strong electrically actuated brakes stand ready to stop all movement of the hoisting sheave. The brakes are so designed that electromagnetic force is used to release rather than to apply the needed friction. Hence, an accidental current interruption involves no risk. Sometimes the hoisting motor is wound to give regenerative braking: that is, it automatically changes to a generator whenever it is

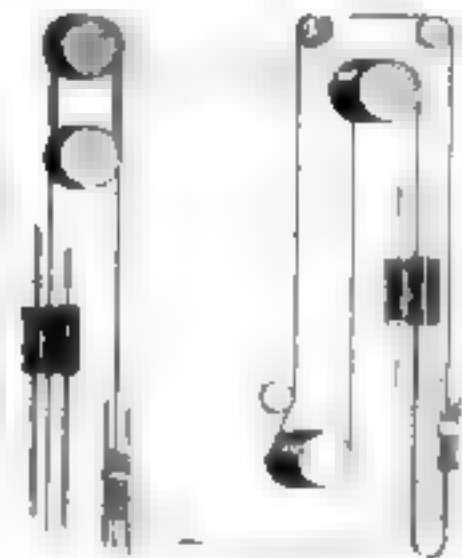
MODERN ELEVATOR SAFETY DEVICES



The overspeed governor works on its own separate cable. If a set maximum is exceeded, it slows the car.



If the governor cable locks, this device beneath the car clamps powerful jaws against a rail, stopping elevator.



The traction drive, left, is contrasted schematically with a drum drive using power applied from basement.

Elevators made skyscrapers possible, but behind-the-scenes equipment and its space requirements limit the height of modern buildings.



Courtesy Westinghouse Electric Elevator Co.

The complexity of modern elevators is concealed from passengers' eyes. In the telescoped phantom view at right, the running gear of only one car is shown. Note the oil buffer at bottom of the shaft.

rotated by an external force. This creates a powerful braking effect that saves wear on the ordinary friction brakes.

The first real safety device, invented by Elisha Graves Otis, was exhibited in 1853. Otis had himself hoisted well off the ground in an open elevator frame, and in full view of hushed onlookers began chopping at the supporting rope with an ax. When the rope snapped, the platform dropped only a short distance before it locked itself rigidly on the guide rails. Mr. Otis then straightened his stovepipe hat and received the applause of the multitude.

The guide rails had a saw-toothed edge that was automatically grabbed by a mechanism on the platform when the cable slackened. Such a stop had practically no resiliency and was soon discarded for more gradual methods of applying braking friction. Safeties operating on the rails are now standard equipment, however, and they operate with a fine precision.

The air cushion, at one time considered a highly effective safety, made use of the compressibility of air beneath the car to give it protection. The lower portion of the hoistway was built to conform closely to the car, and spring- or oil-retarded bumpers were installed in the pit. Air valves were provided near the bottom of the shaft, both to prevent too rapid a stop and to admit air for upward travel.

A car was once experimentally dropped 287 feet into a 50-foot air cushion without breaking a basketful of eggs inside. One of the cushion's promoters dropped 20 stories and landed uninjured, but with the chair in which he was sitting festooned about his ears. Some elevators are still protected by air cushions, but the system is out of favor now. A cushion will operate nicely enough if the lower doors don't blow out, but there is some difficulty in adjusting the air valves

for all likely passenger loads, and for a stop that is both sure and not too sudden.

Since lifts attain speeds as high as 1,400 feet per minute (about 16 m.p.h.) nowadays, operators cannot readily "land" cars at specified floors by "inching," without wasting time and power. Consequently, cars are slowed to stops by an automatic floor selector, an intricate relay system that is capable of remembering all buttons pressed and dispatching a bank of cars as the buttons request. Another complex device, using selector tapes, vacuum tubes, or induction coils, then takes over and levels the car to a fraction of an inch. At the soonest safe moment during the "landing," the doors are automatically opened. Any slight changes in car level during loading or unloading are delicately and automatically corrected. A photoelectric cell prevents the power-closed doors from nipping an indecisive passenger. One recent elevator handbook remarks that "snappy operating equipment has the psychological effect of causing passengers to move quickly." Thus, even our behavior is being tampered with by the engineers.

To save shaftway space, one New York building has experimented with double-decked cars, set in the same frame and fitted with interlocked controls. One passenger compartment stops at even-numbered

floors and the other at odd. Willfully stupid people, of course, take the wrong car. An even more advanced installation was tried in East Pittsburgh, with two independent cars running in the same shaft, protected from each other by red-and-green block signals.

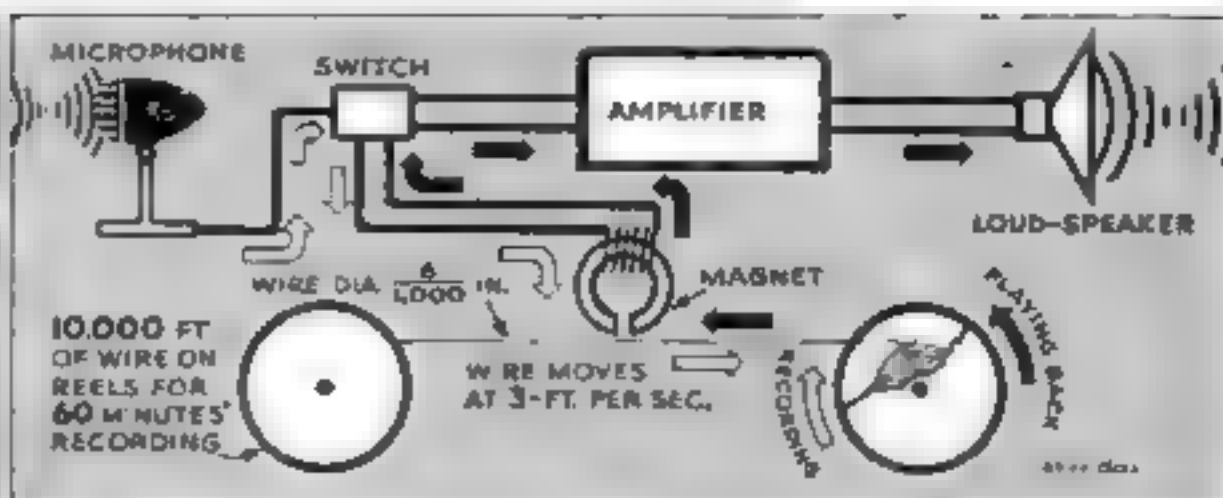
In some future skyscraper you may find continuous elevators that go up one shaft and down another, like buckets in a dredge. Another scheme on the drawing boards will locate a "focal load center" about halfway up a building. Fed by a bank of express elevators, this center will act as a terminal from which local trips can be made to specific floors. These lofty load centers may, in addition, be connected by bridges with similar centers in neighboring buildings.

An elevator can, without causing discomfort, slow down about $1\frac{1}{2}$ times as fast as it can start up; and it can painlessly start upward somewhat faster than down. Most people can withstand an emergency stop of up to three times gravity without major injury, while twice gravity might leave you still standing if you had sturdy underpinnings. It's a pity that we can't withstand really high decelerations, because an elevator can theoretically start down so fast that the passengers would float down without touching the floor. *(Continued on page 206)*

If the hoisting rope of this early lift broke, saw-toothed guide rails were promptly engaged by metal dogs. The idea was patented by Elisha Otis in 1852.

The Frenchman ascending with such dignity is M. Amiot, who in the early nineties built himself this chain-driven escalator for use in a circular stairway.





Left, recorder in use. Above, sound is picked up by microphone, passed {white arrows} to magnet which magnetizes wire from reel. Magnetic field varies to match tone peaks. For playback {black arrows} wire passes through magnet, sending vibrations through to speaker.

War's Wire Recorder Now Civilian "Camera of Sound"

THE wire recorder was busy in the war making on-the-spot records of important goings-on that otherwise could not have been made. Transcriptions of epic events, of pilots' reports on combat and reconnaissance flights, and of enemy conversations wangled by Allied counter-intelligence agents made the machine invaluable.

Recordings are made by magnetizing a fine steel wire. The complete unit is compact, light in weight, and simple to operate. It can be built into modern radios, and has so many other possibilities it may well become a "camera of sound." Baby's first words can be caught and locked away. Sound tracks for the family movies and for sports events can be made. Famous sounds—Niagara Falls, Old Faithful, the President's voice—can be collected like autographs or stamps. Industrial and educational possibilities are as numerous.

The wire recordings play back with high fidelity, and can be stored without deteriorating. Lengthy recordings can be heard from

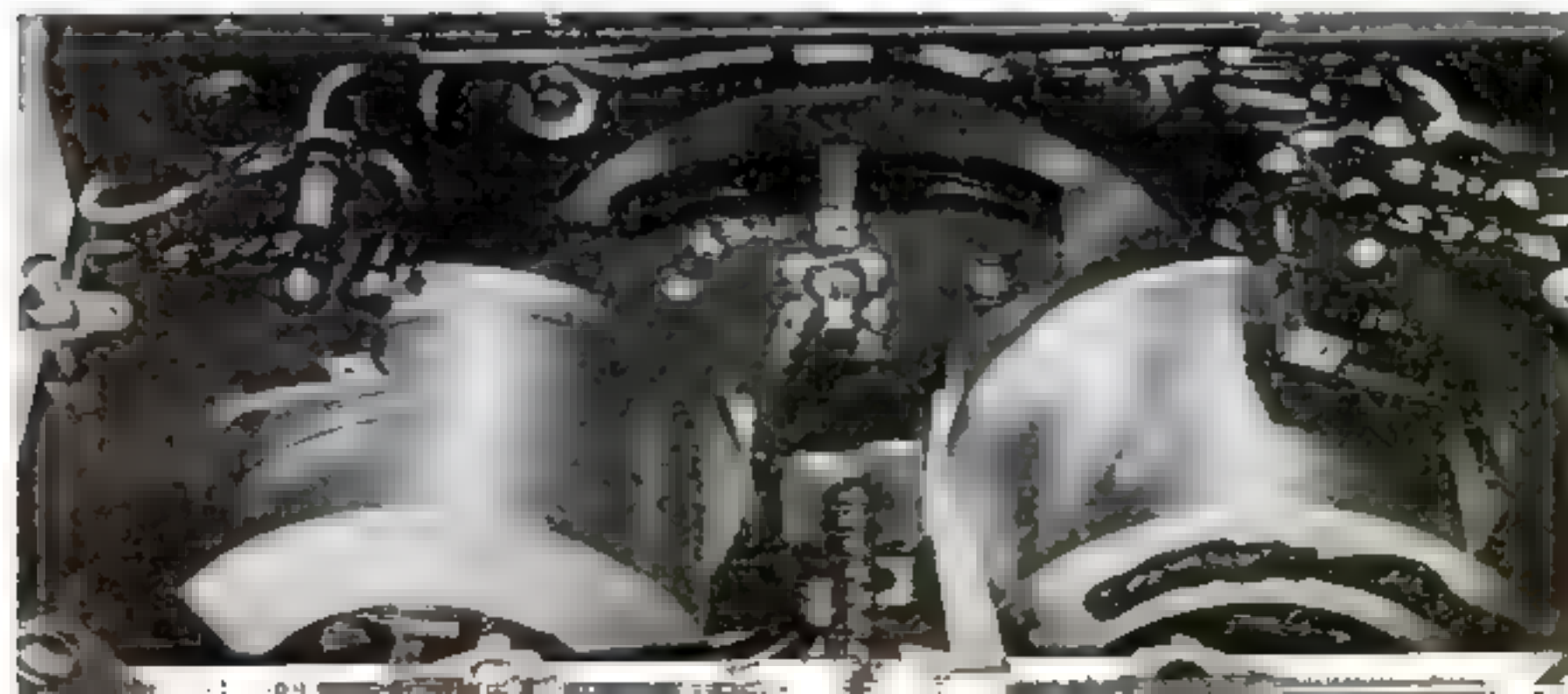
start to finish without interruption. A timer lets you play any particular portion. The sounds can be erased and new recordings made on the same wire.

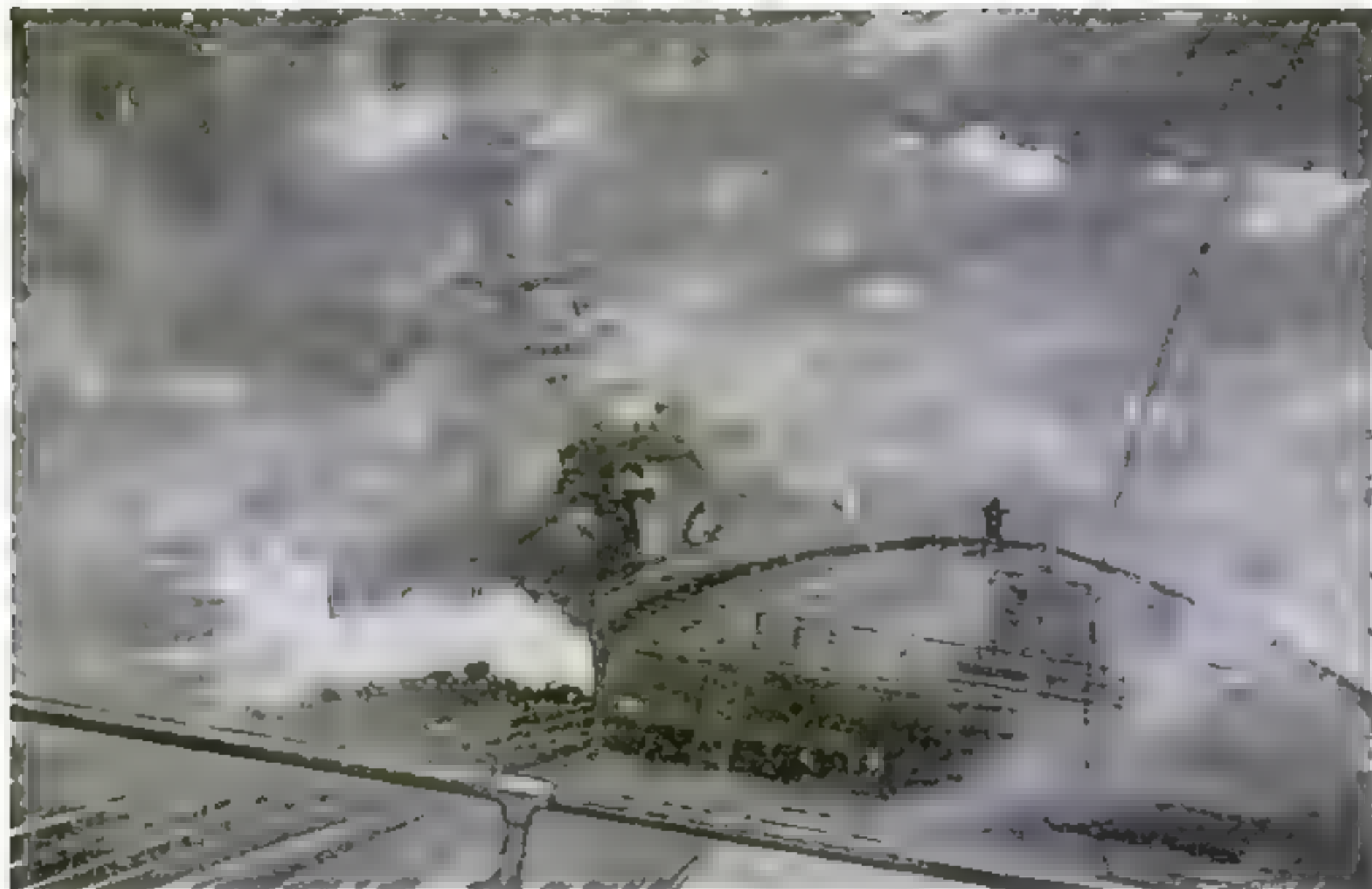
The latest-model recorders can be carried in your pocket. Any type can be battery-operated for portable use.



George Hicks (left) used recorder in epic D-Day transcriptions. Here, he records in mid-Channel.

Inside the recorder: reels holding nearly two miles of wire, and magnet are seen. Wire must be rewound before playing back, otherwise voice is heard in reverse, and sounds like Donald Duck. Selector unit has switches for recording, playback, erasing, and other functions. Recorder requires no attention after starting.





"Sound Collision Quarters!" Ships cannot be stopped like automobiles; they must be handled skillfully in that minute of danger and decision to avert crashes like this one between a battleship and a transport.

COLLISION AT SEA

**Young Skipper's School Reduces the Peril.
13,000 Crashes in War Are Costly Lessons**

By **LEON SHLOSS**

THE Japs tried desperately for three and a half years after Pearl Harbor to put an American battleship out of action—and failed.

Where the Japs failed, the Americans succeeded. We put not one, but two of our own most modern dreadnoughts out of action in a few brief, terrible moments at a critical phase of the war—because we had no scientific method of avoiding ship collisions.

Nearly 150 times during World War II the Navy lost, forever or temporarily, vital warships as a result of collisions. The Merchant Marine suffered as many as 10 collisions daily. There were nearly 13,000 collisions in all. They cost a billion and a half dollars, hundreds of lives, and irretrievable time. But the Navy found a way, largely through the efforts of a young reserve officer, virtually to eliminate ship collisions before the war's end.

COLLISION CASUALTIES



4 aircraft carriers



7 battleships



2 medium carriers, 1 baby flat-top



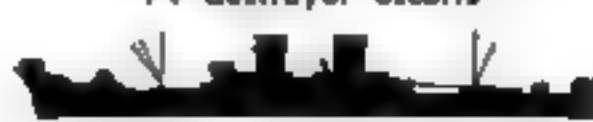
2 heavy cruisers



45 destroyers



14 destroyer escorts



12 cargo, transport, oiler types



30 LST's (landing ships, tank)



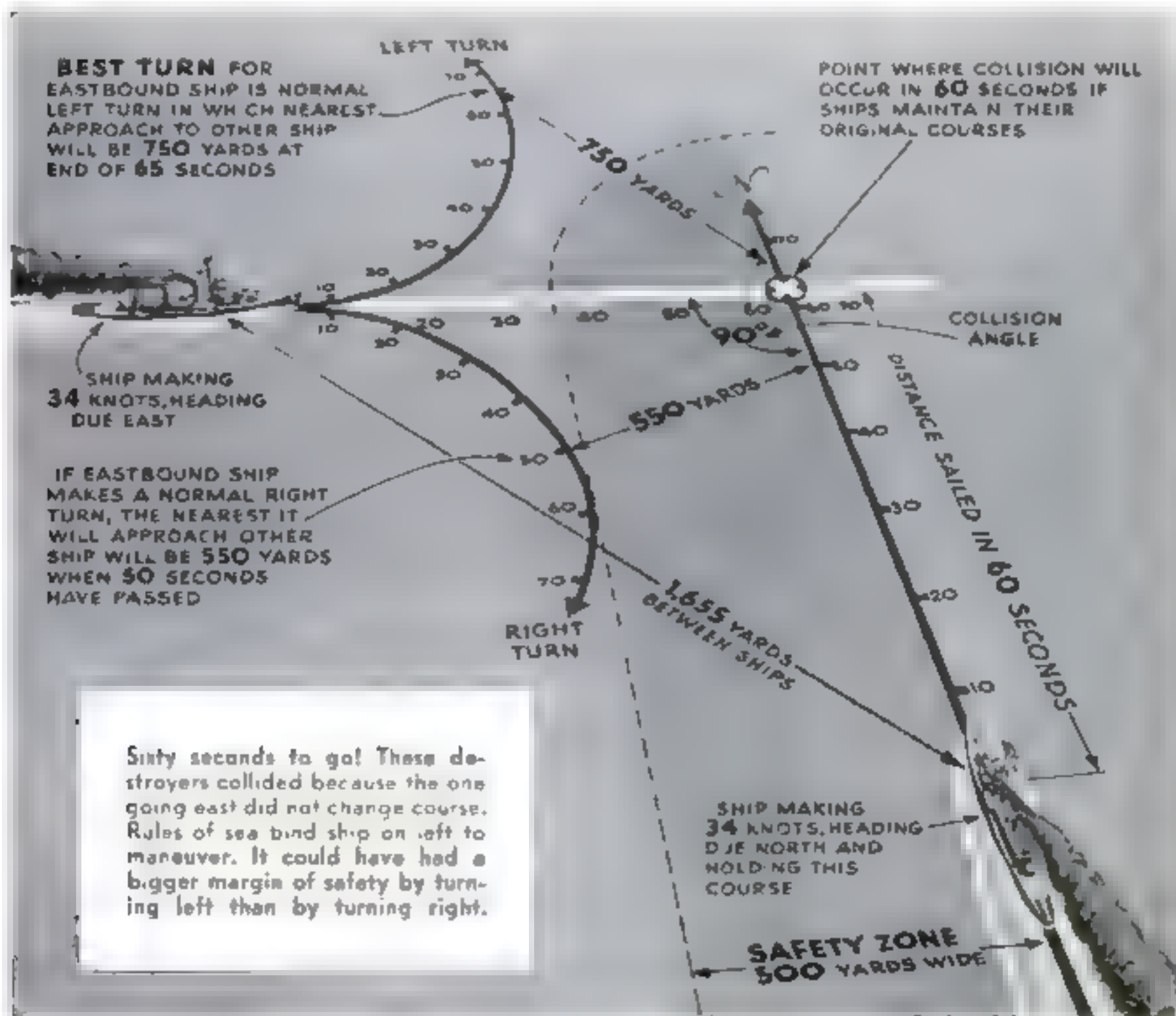
The collision that denied the services of two badly needed battleships to the Pacific Fleet sparked the events that remedied the situation. This collision occurred in February 1944, right after we had taken Kwajalein. Saipan, Tinian, Guam, the Palaus, and the Philippines were to follow, but for many anxious weeks after this accident, high-echelon councils wondered whether the scheduled offensive should be continued without the two battlewagons. Battleships, at that phase of the war, had just been robed with a new importance. It had been discovered that these monsters, given a main deck full of antiaircraft guns, could provide a steel shield under which aircraft carriers, spearhead of the fleet, could move within excursion-boat distance of enemy shores.

The two ill-starred battleships were, in fact, tantalizingly close to the Jap homeland when the setback occurred. The Fast Task Force in which they were operating was looking for trouble. It found it, however, in a most undesirable shape, the shape of its own ships. At four o'clock in the

morning, Battleship A was ordered to leave the formation. She started to pull off to the left, when her radar picked up a group of ships on her port side, on a collision course. So A came right, in an attempt to cross Battleship B's bow. When the captains of the two ships realized they were on a collision course, they resorted to the then-current collision-prevention doctrine of turning toward each other's stern. Battleship B got her bow knocked off in the ensuing crash, and was out of action for many weeks. Battleship A was damaged and was out for a lesser time. At least six men lost their lives.

Under the system evolved after this tragic mishap, Battleship A, by pulling ahead for some distance before turning out when ordered to leave the formation, would have avoided the collision.

The new system was part of the revolution in naval warfare that was necessitated by World War II. The Navy's fleet, at Pearl Harbor numbered in hundreds, contained more than 90,000 units by V-J Day. The old fleet line, moving majestically, was





At the Navy's Emergency Shiphandling School, Junior Officers of the Deck (JOODs) use synthetic devices to sight on model ships, then relay their bearings to Officers of the Deck (OODs) up on the "bridges." Radar plotters (center) chart positions.

replaced by the Fast Task Force. This force numbered hundreds of vessels, bows splitting swells at 20 to 30 knots, often engaged in violent evasive maneuvers to confound the enemy's radar-controlled gunfire, rocket and torpedo attack by aircraft, submarine wolfpacks, and all the other new weapons of war. The old preradar doctrine of avoiding collision, based on "when in danger, turn toward the stern of the other ship," just wasn't working, and it wasn't working so often that, following the battleship accident, then Fleet Admiral Chester W. Nimitz called attention to the mounting collision rate in a letter to the Pacific Fleet and made it incumbent on all commanding officers to give renewed consideration to the fundamentals of safe maneuvering.

Not only was the number of collisions disturbing, but so was the nature of many of them. On a black night in the far western Pacific a ship, with newly installed



A JO's equipment includes the communications unit on the wall for talking to the bridge, whistle button, captain's call button, siren, and ship's bell.

radar, picked up an approaching vessel at 33,000 yards. Engrossed with their new instrument, the Radar Plot crew tracked the other ship with amazing accuracy—right up to the moment the two ships met head-on. In their absorption, they had neglected to inform the captain that another

Up on the teacher-ship bridge, an OOD sights on a model ship through reversed binoculars to create the illusion of distance. Ship's helmsman is at right.

Here's an OOD's equipment: reversed binoculars, talk-between-ships radio, ship's intercommunication unit, and microphone to record talk between ships.





Auditorium-size classrooms are planned for future shiphandling schools, founded by Lt. Comdr. Davis N. Lott. Students watch ships' images, projected onto screen electronically as ordered by OODs in the booth "bridges," maneuver in convoy and task-force problems. Twelve-ship schools, like the above, are planned.

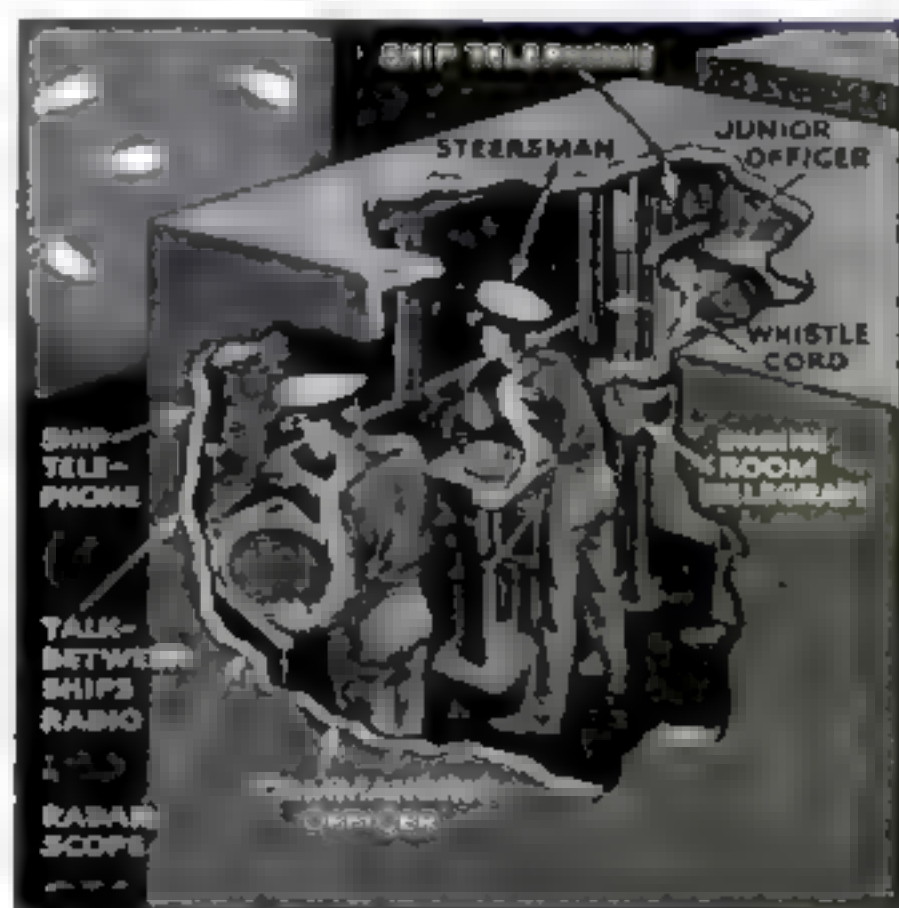
ship was approaching with a closing range and a steady bearing—the two danger signals which experienced officers know spell "COLLISION!" The two vessels had been on a perfect collision course for 17 miles!

On another dark night, two destroyers were screening a Fast Carrier Task Force. Both captains were snatching forty winks in their sea-cabins. Running on a parallel course, the formation was ordered to commence the zigzag plan at 20 knots. Ship A came right, while Ship B—which had failed to receive the radio order for zigzag—continued on a steady course. The next zig sent Ship A away from B. Then B noticed what its deck officer considered A's apparent difficulty in holding course, so B came left in an effort to maintain station. A zigged right and actually passed astern of B, placing A starboard of B. The conning controlling officers of the ships then were looking for each other's vessel on the wrong side! A's next zig pointed her bow directly at B's beam. B failed to sight A until the range was 300 yards. A never did sight B, as she was still looking for B on the wrong side. B used rudder and engines to avert collision, but sounded no whistle signals and used no lights. B's TBS (Talk-Between-Ships radio) was inoperative, so she couldn't warn orally. A serious collision resulted.

At the time Admiral Nimitz's letter on avoiding collisions was circulated throughout the Pacific Fleet, the records were full of collision cases where conning officers had

erred either in commission or in omission through failure to utilize all their tools, such as radar, lights, whistles, and radio. Aboard the minesweeper U.S.S. *Clamour*, 32-year-old Lt. Comdr. Davis Newton Lott, the skipper, who had interrupted a movie-radio career to fight the Axis, read the Admiral's letter, and set to thinking.

Lott had written two naval texts dealing with ship recogni- *(Continued on page 207)*



Inside a "bridge" of the proposed school, an OOD watches maneuvering ships' images on the radar scope. JO, right, transmits orders to engine room.



LOOKING DOWN into the telescope's eye, the observer may focus it on stars a billion light years away. Cylinder supports a double-slide plate holder.

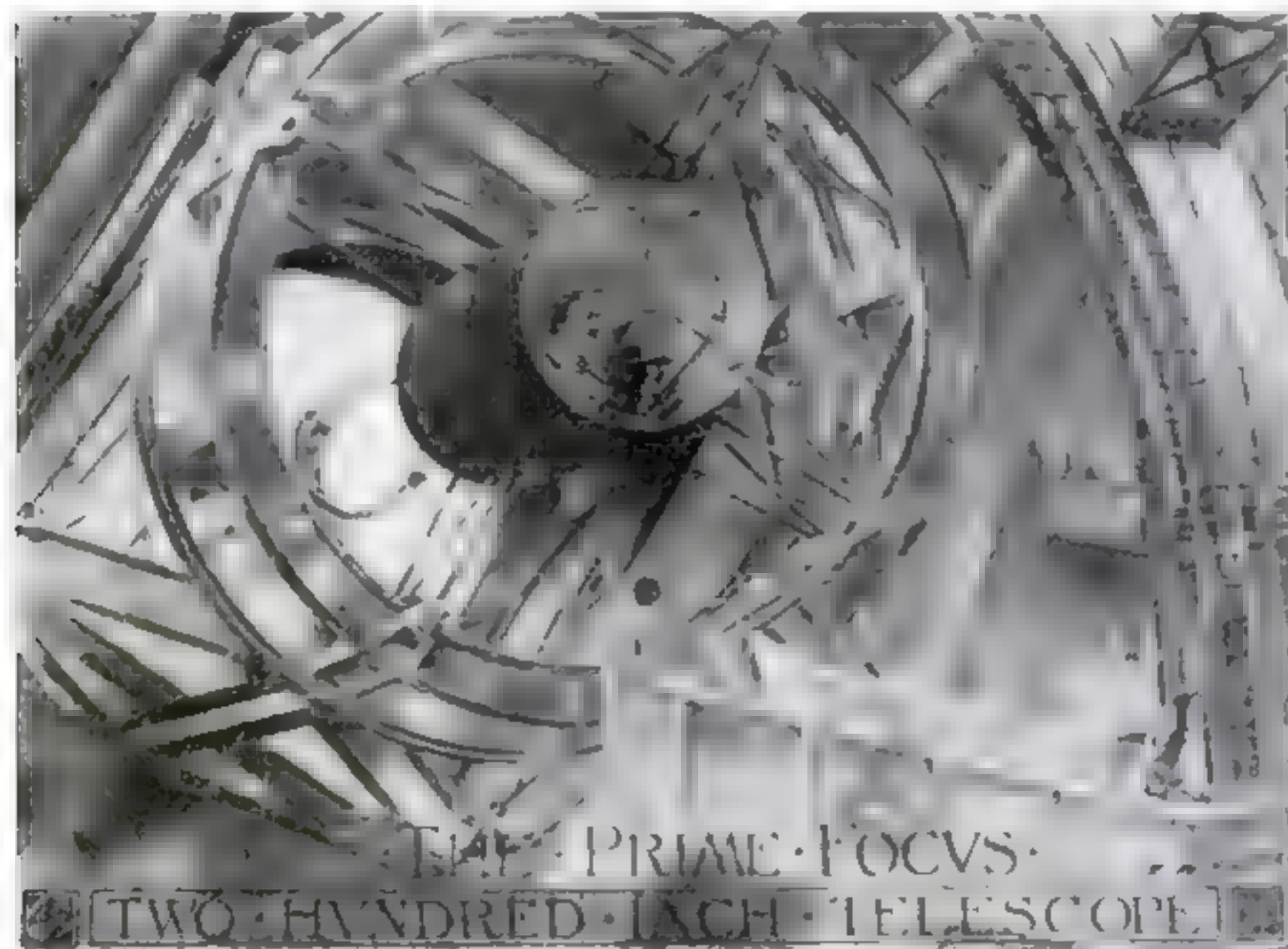
A MOVABLE BRIDGE, riding on a curved track, will take the astronomer to and from the prime focusing point at upper end of the tube. Huge mirror reflects light to photographic plates.

INSIDE THE

THE great 200-inch telescope of the California Institute of Technology on Mount Palomar in southern California is now scheduled to go into action in about 18 months. World War II, draining the nation's scientific talent, abruptly halted the construction of the biggest spyglass in the world. Now, experts have resumed the task of completing it. The cover of this issue of **POPULAR SCIENCE MONTHLY** shows how the instrument will look. A dome 10 stories high will house it.

To give an idea of the power of the 140-ton tube, it would make New York's Empire State Building visible from the moon, in the absence of intervening clouds and haze. New light will be thrown upon the possibility of life upon our neighbor planets. To astronomers, one of its most interesting uses will be to discover almost inconceivably remote galaxies or universes. For comparison, our own galaxy is the Milky Way, in which the sun is a typical star.

In theory, since the light-collecting power increases according to the square of the diameter, the Palomar instrument should



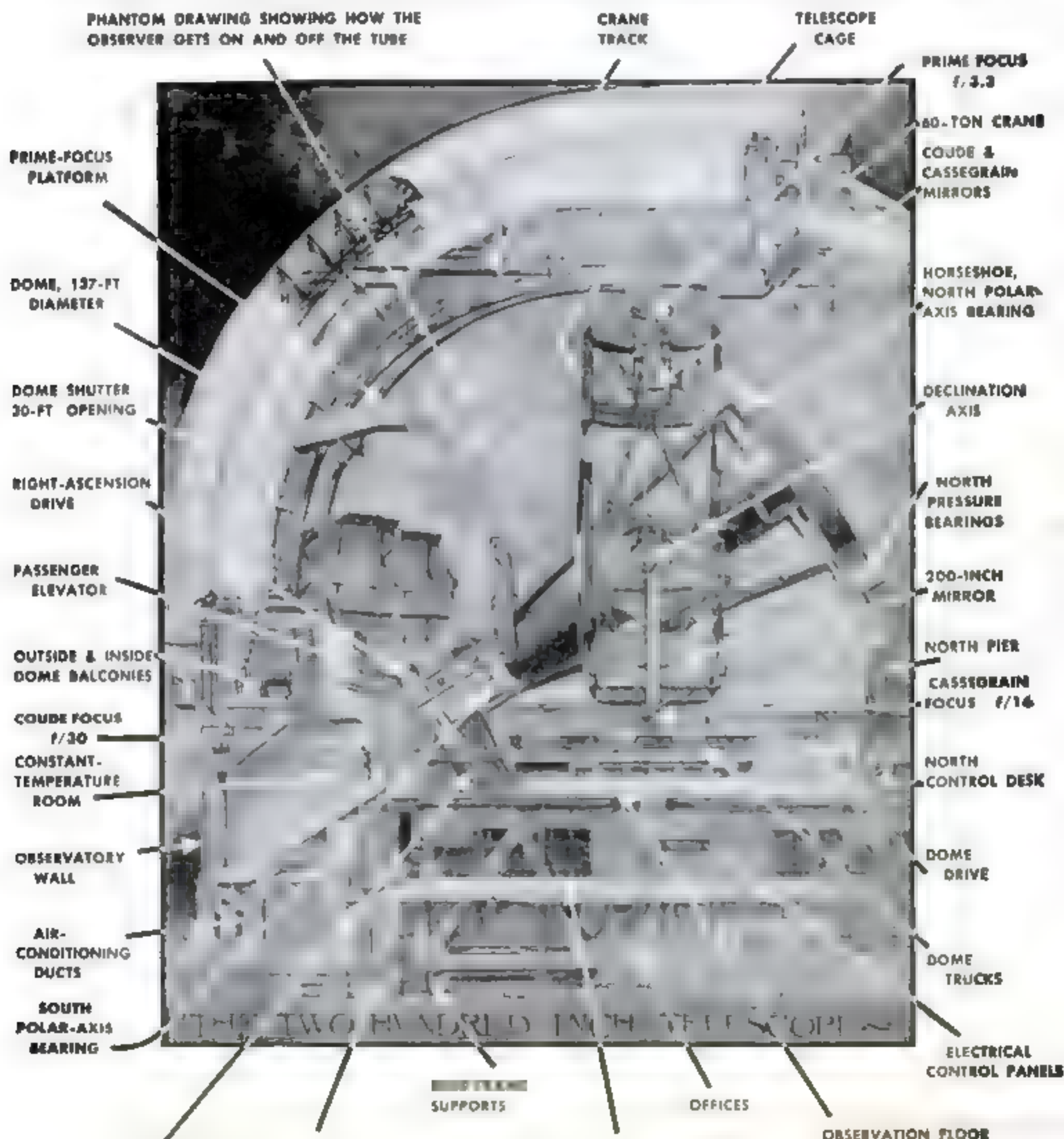
WORLD'S BIGGEST EYE

prove four times as powerful as the 100-inch Mt. Wilson telescope in current use. Actually, later refinements in steady mounting will probably better the figure. This becomes especially important in taking long "time-exposure" pictures of faint stars.

Observers at Mt. Palomar will rely almost exclusively upon photographs for their

records—for the eyes of different people do not always see alike. Some see canals on Mars. More skeptical stargazers believe that the markings of the red planet are exaggerated and joined by the imagination of the viewer, much as the ancients saw wild beasts and mythological characters in constellations or star groups and recorded

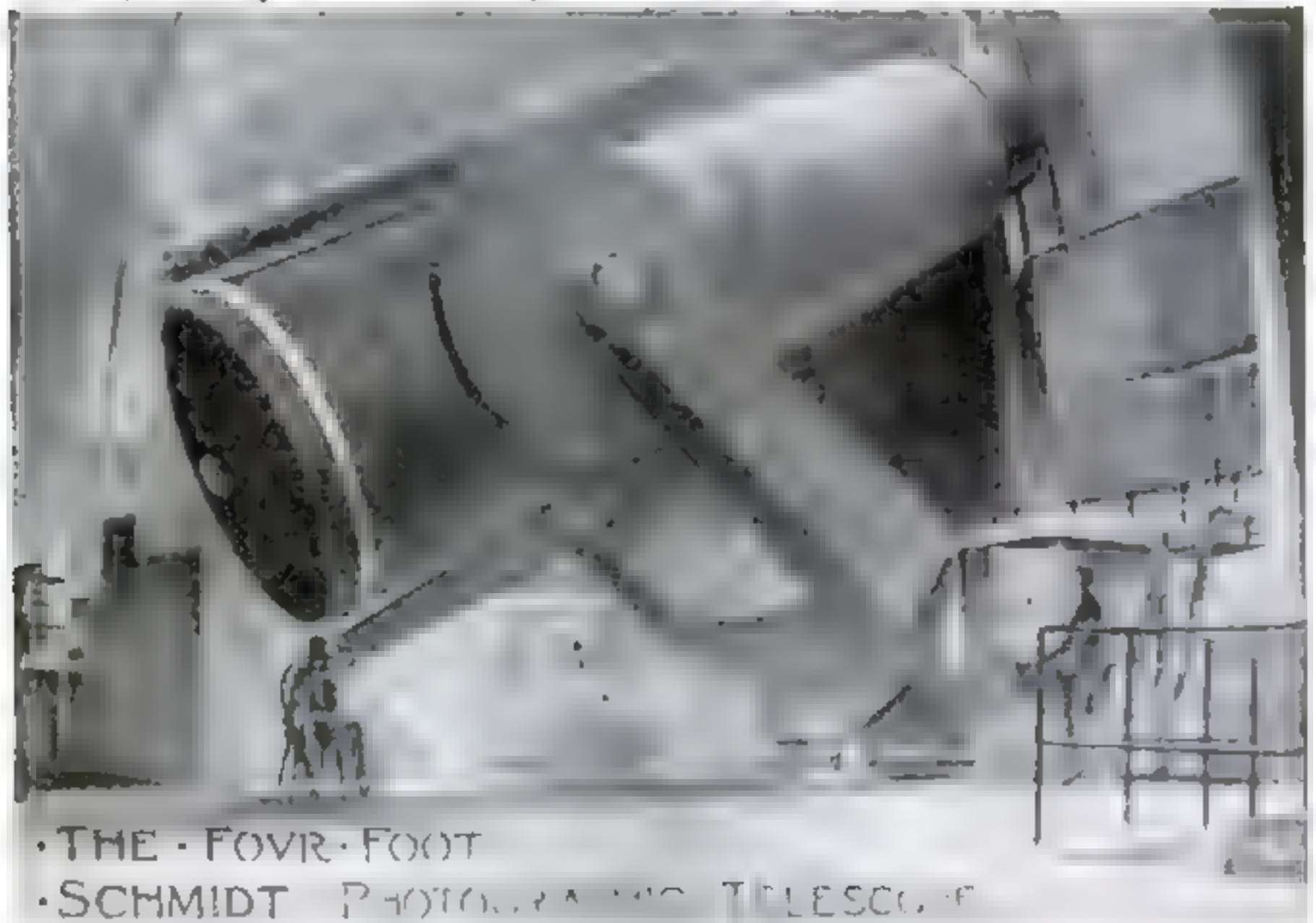
A TEN-STORY DOME will house the 200-inch telescope. The dome weighs 1,000 tons and the instrument 500 tons. Cutaway sketch shows the principal features and three of the positions of the upper and of the 140-ton tube. These drawings were made by Russell W. Porter of California Institute of Technology.





MIRROR SURFACE of special aluminum may be renewed at the site. Mirror will not vary from perfection by more than two millionths of an inch.

SCOUTING TELESCOPES will find objects worthy of the great eye's time. This one will photograph an area 3,000 times greater than 200-inch giant. Note guiding telescopes above and below camera tube.



• THE • FOUR • FOOT
• SCHMIDT PHOTOGRAPHIC TELESCOPE

them on the decorative charts of the day.

To obtain its enormous magnification at its principal focus or observing position, the sky camera receives a cone of light only one fifth to one third the width of the full moon. Therefore, smaller "pilot telescopes" direct the big one. Carefully balanced, its barrel rises and falls, and the whole dome revolves with it, virtually without friction, on films of oil forced through bearing pads.

Not only will stars and nebulae pose for their pictures, but their light will be transformed into a spectrum or rainbow, permitting the observer to see what they are made of. Celestial events, such as the birth of novae or exploding stars, will be filmed as they occurred in prehistoric times, since photographs will pick up stars so far away that their light takes 1,000,000,000 years to reach the earth.

Like other great telescopes, the one at Mt. Palomar employs a concave mirror to form an image. Varying the optical system provides a number of observing positions, including those familiar to astronomers as the prime focus, the Cassegrain focus, and the Coudé focus. These are indicated in an accompanying drawing, together with their speed rating in the "f" system in general use by photographers. Low numbers mean short exposures.



"Motorcycle of the Air" Used In Jet-Fighter Research

ROCKET-propelled "Project 12" previously a Wright Field secret, is a novel flying-wing design in which the pilot lies on his stomach, his chin on a V-shaped rest, and looks out through a Plexiglas nose faired into the wing's leading edge. In the prone position he is best able to tolerate the increased accelerations which great speed entails. Built by Northrop, the wing blazed a trail for the hot new XP-79, jet-propelled, flying-wing fighter.

Controls of "Project 12" are hooked up to a handlebar. When the handles are upright, control surfaces are neutral. Pilot bends the handles forward to nose down, backward to nose up, and to right or left to bank the wing. To turn, he moves the handlebar as if he were steering a motorcycle. The throttle is within easy reach of his left hand; other switches are near his right. The pilot enters the wing through a hatch in the top, which has an automatic opening device for emergency bail-out.

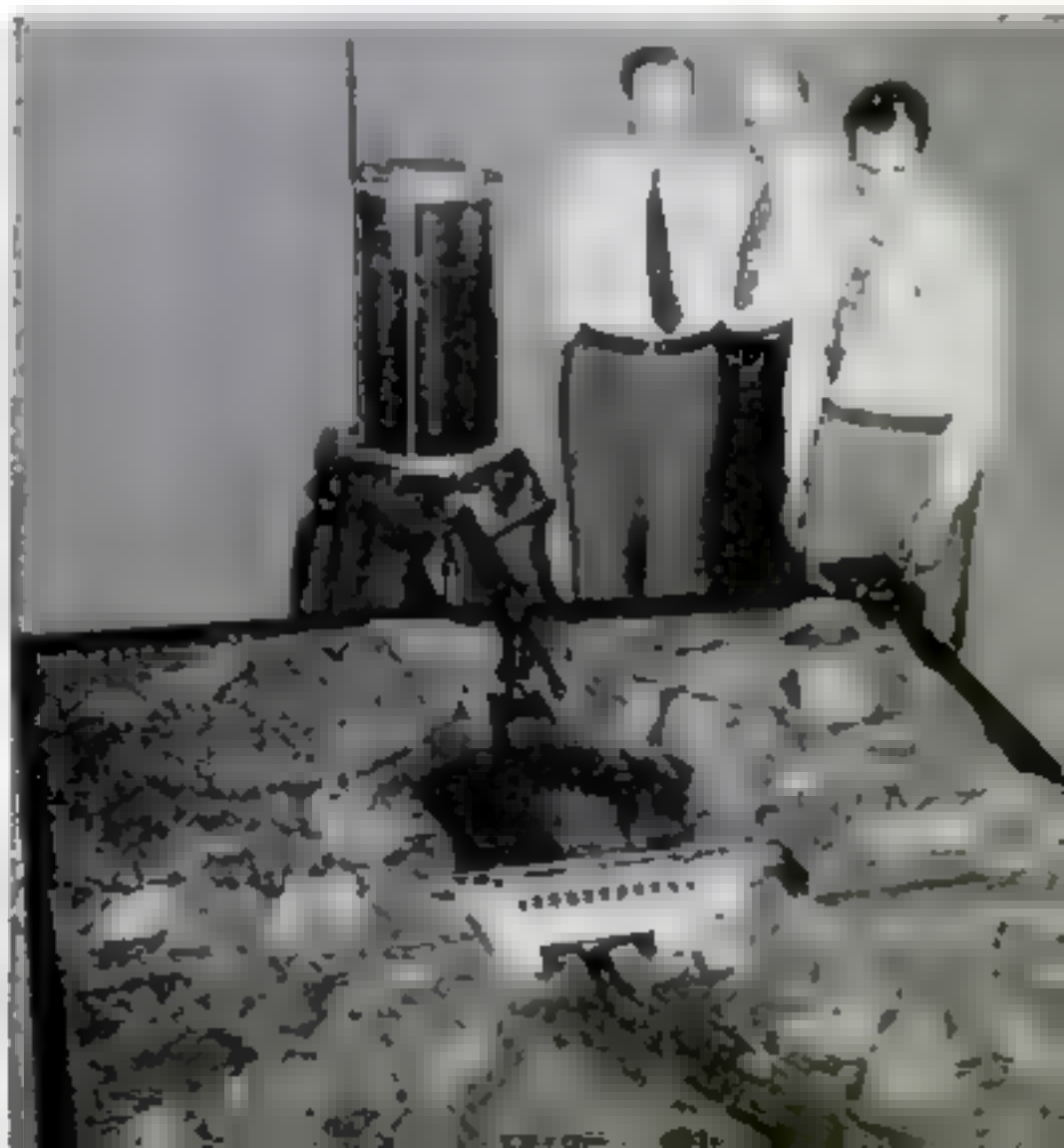
Floods Are Made to Order In Scale-Model Valley

FLOODS rise and fall at the flick of a switch on this electrically operated scale model of a dam and river valley. Arkansas Power & Light Co. built it to show the Southwest why flood-control dams need empty reservoirs to store water and let it out gradually; why power dams must have full reservoirs and therefore are not useful in the control of floods.

JANUARY, 1946



"Project 12" is easy to fly, test pilots found, after a little practice. The unusual flying wing has fixed, tricycle landing gear and bellows-type flaps (above).





Every meet of the Motor Sports Club of New York features cars of many foreign and American makes.

SPORT MOTORING

Driving pet cars in races of skill is fun for this new club.

TO MEMBERS of the Motor Sports Club of New York, the automobile is more than transportation; it is a hobby and a sport, much as it was in the early days of gas propulsion when a car was a family pet. Most of the cars so lovingly tuned and polished by their owners are of foreign make, but there are some standard American models too. The chances are that pretty soon somebody will come along with a jeep, and, more than likely, he'll make Club history.

On a typical week-end meet the boys and girls (about half as many women as men belong) rendezvous in the Plaza at the south end of New York's Central Park. As each of the heavily powered jobs arrives, a new motor tune can be recognized. A dinky jewel-like English Standard Swallow takes its place beside a stately Rolls Royce, and

a Delage from France touches bumpers with a low-slung Italian Lancia. There is a 1928 German Mercedes, and an American Hudson with a 19-foot custom body. In line with their sporting instincts, the Club members go in for picturesque cars.

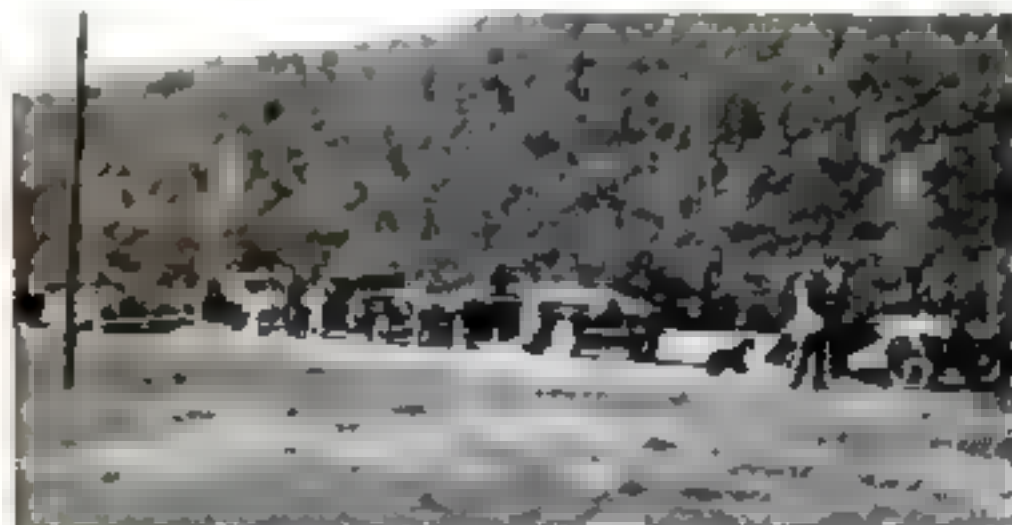
The scene of the meet may be in Great Barrington, Mass., Westport, Conn., or some abandoned airfield on Long Island, wherever a couple of acres of open ground is available. Sometimes the convoy arrives in the evening; then members nose their cars into a large circle around a campfire and talk superchargers, high-octane gas, and whatnot while supper is cooking.

In the morning comes last-minute grooming. Amateur mechanics change spark plugs, adjust timing, tinker with carburetors to get the best possible performance for altitude and climatic conditions. The



Members meet in front of the Plaza Hotel, New York.

At night the cars gather around a big campfire.



They make a brief lunch stop halfway to the meet.

Last-minute adjustments are made before the start.





Neighborhood kids get a great kick out of the fun.

course to be run is laid out and handicaps given each car. A succession of events is staged to test the skill of the driver as well as the response and stamina of his car.

The contests involve sharp turns, backing up, and a complete loop, to say nothing of the driver's having to stop, get out, and run around his bus before continuing. An event may end by the cars weaving around stakes in a roaring dash to the finish. One of the most popular contests is the "bang and go back" race, in which cars line up, and, at a given signal, tear straight ahead for 100 yards, stop, and then in reverse go back to the starting point.

Handicapping is figured on wheel base, since the larger cars have more difficulty than the small ones in turning and backing. Three seconds are allowed for every five inches of wheel base over the shortest scratch car. Incidentally, in a recent obstacle race a big Rolls Royce finished fifth.



Diagram of course used in meet. Flag denote turns.



This 19-ft. body was built on a Hudson "8" chassis.



A girl expertly handles a 100-hp. Standard Swallow.

while a little old Ford came in just after the winning Italian Lancia. This emphasizes the fact that the Motor Sports Club of New York is not a high-hat organization. There is no initiation fee, and there are no dues. All one needs is a car, a keen interest in the sport, and the price of a dinner at the restaurant where the occasional meetings are held. The president of the club takes care of notifying the members when get-togethers are planned.

This kind of sport driving need not be expensive, for any type of car from a jalopy to a truck may be used. The skill of the driver is as important as the size of the car. It can be exciting without danger. There have been no serious accidents among the contestants at Motor Sports Club gatherings. Members claim that more of these motor sports clubs throughout the country would help to raise driving standards, lower automobile accidents.



British Invicta backing in a "bang and go back" race.



One contestant drives his 1934 Lancia, V-8, Astura.

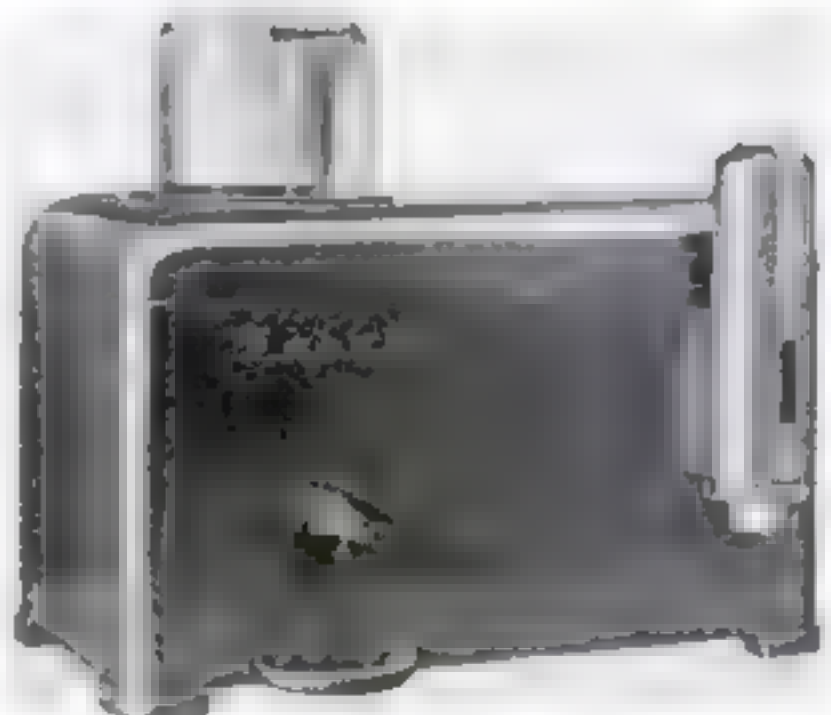
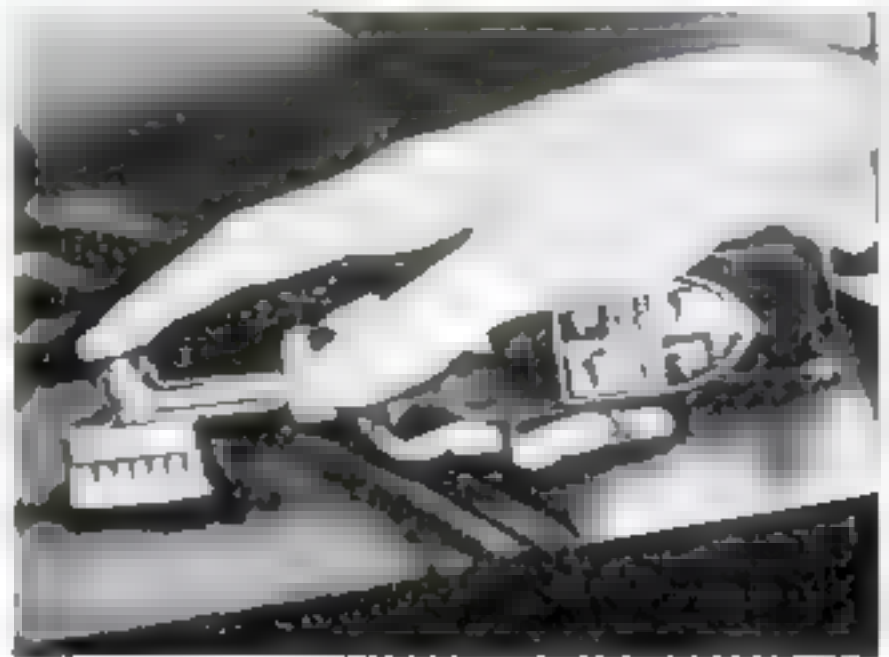


HOT FOOD can be kept right at hand throughout the meal by use of a novel glass-topped dining table included in a display of new furniture presented by R. H. Macy & Co., of New York. In the center of the table is a steam compartment for cooked foods. Thus, housewives can prepare a meal for a dinner party, place it in the compartment, and take as long as they want to welcome their guests. When it's time to eat, the hostess can serve dinner without rising.

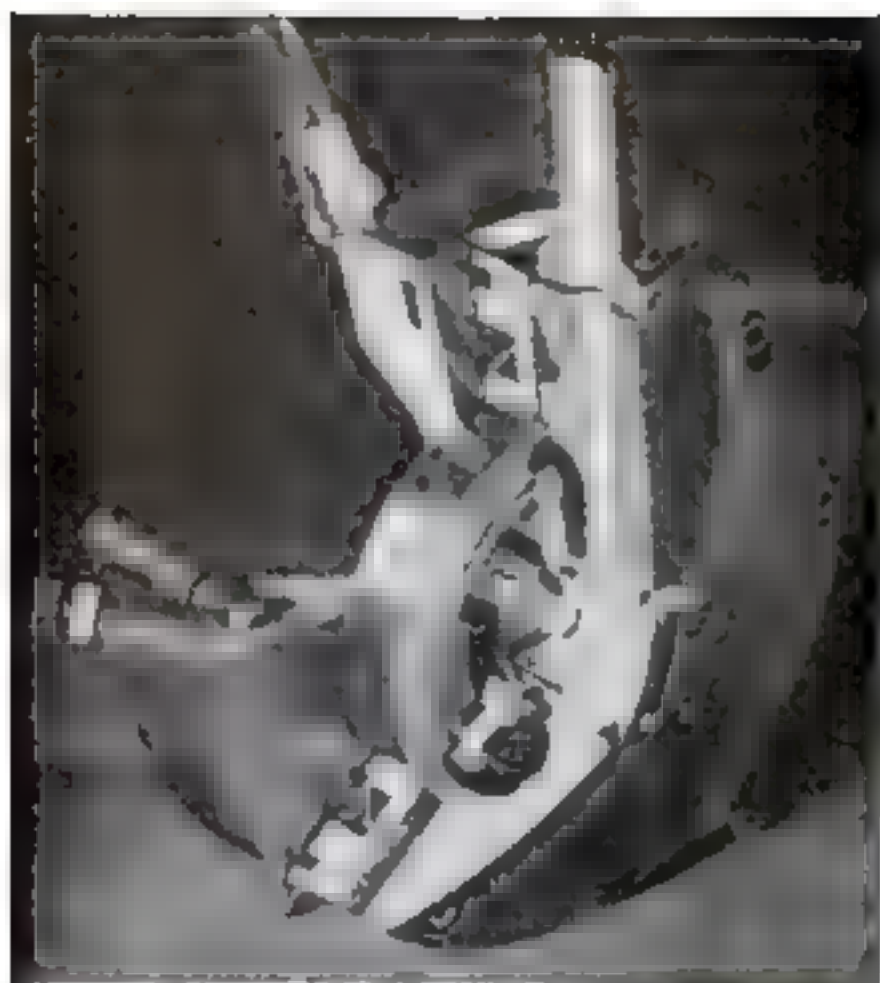
NEW HANGERS designed to lessen the possibility that women's skirts will become wrinkled are shown in the photo below. Two curved devices hook on an ordinary wire hanger. They are easily adjusted to the width required to fit inside the top of the skirt and hold it taut so it cannot fall. The hangers are manufactured by the Canton Metal Decorating Company, of Canton, Ohio, and distributed by M. S. Glover, of Akron.



CLEANING FLUID is contained in the bottle that serves as a handle for this dry-cleaning brush produced by the Rivet-O Manufacturing Company, of Orange, Mass. When spots or stains are being removed from clothing, gentle pressure on a fingertip control button allows a small amount of fluid to flow through the brush and reach the clothing. The bottle can be refilled.



EASILY CARRIED from room to room, this small and compact water cooler may prove useful in private homes, although it is intended for use also in offices, hospitals, hotels, clubs, and elsewhere. Manufactured by the Norge division of the Borg-Warner Corp., Detroit, Mich., the cooler is powered by a 1/12-hp. hermetically sealed electric unit. The cooler is approximately 12" by 13" by 22", and it has a capacity of 1½ gallons of water. A cup dispenser is attached to the front of the cabinet.



Tires are inflated on the run through this hub joint. The inner part rotates, but the outer doesn't turn.

PUMPING UP A MOVING TIRE

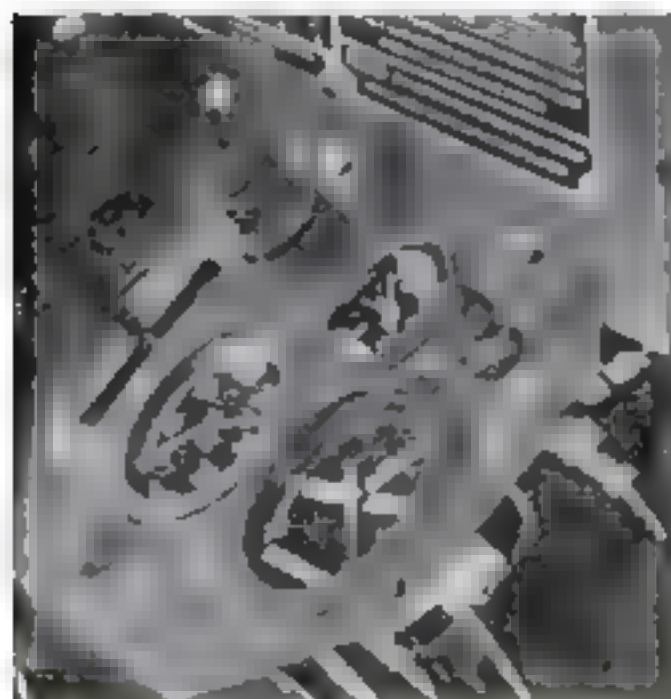
Dashboard Control on Duck Changes Pressure to Suit Terrain

MAINTAINING proper tire pressures may be possible on civilian cars and trucks without stopping the vehicle if Army experience is any criterion. Ducks—those General Motors trucks at home both on land and water—had central tire control for the last two years of the war. Simply by manipulating valves from his seat, the driver could increase or lower tire pressure at will. Thus, the duck could hit a sandy beach with 12-lb. pressure in its tires for maximum flotation and traction, and once beyond soft terrain could have the pressure increased to 40 lb. without ever slowing down.

Air is admitted or released through a rotating pressure joint attached to the hub,

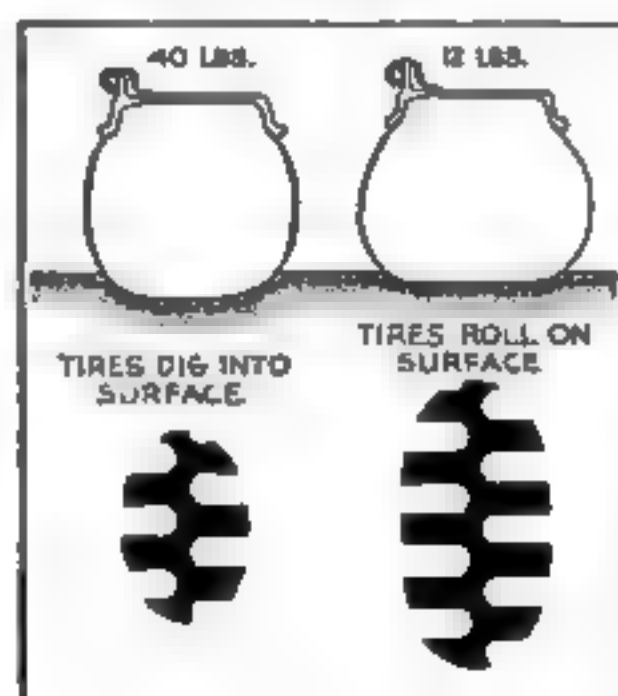
the inner, rotating member of which is shown at the left of the cutaway above and the outer, stationary member at the right. The air line from the dashboard control enters the stationary section, and a hose in the rotating member makes contact with it through a finely adjusted steel nose and plastic disk.

Each wheel is equipped with such a rotating joint sealed against sand and salt water by synthetic rubber under pressure of a large spring. Individual units can be controlled by separate valves or all by a single lever (left below) on the dashboard. A gauge gives tire pressure at a glance, and a plate above it lists correct operating pressures for various types of terrain.



Operating the lever on the extreme left of the part of the dash shown automatically changes pressure. The gauge is marked for sand, coral, and highway pressures.

Desert-type 11.00 by 18 tires on the Army duck have few plies and flex easily to increase the contact area and give better traction on sand when pressure is low.



GUS PLAYS SECOND FIDDLE

GUS WILSON was hard at work on the second morning of the winter's first real cold spell when Doc Marvin came into the Model Garage shop with a worried frown on his normally cheerful face.

"Hello, Doc," Gus greeted him. "Back from the State medical meeting, I see. Have a good time?"

"Yes and no," Doc told him. "Mostly no. I had trouble with my car, and although I handed quite a chunk of coin over to those hijacking garage men up there trying to get it fixed, it's as bad now as it was before they went to work on it. Take a look at it as quickly as you can, will you, Gus? I've got several cases scattered all over the county to attend to this afternoon, and to save my own life I can't get over 30 miles an hour out of the old bus."

"O.K., Doc," Gus agreed. He waved a hand toward the cars crowding the shop floor to capacity. "You can see for yourself what I'm up against today—but I guess no one needs a car as badly as a doctor does, so I'll slip your job into the No. 1 spot. It isn't often you have car trouble you can't take care of if you have to. What's the matter with your car, anyway?"

"From some of the symptoms it's displaying," Doc said, "I'd guess that it's this cold weather. But from some of the other symptoms, I'd say I don't know what it is. One of the ways I keep my patients and myself out of most serious trouble is by calling in a specialist for consultation whenever symptoms don't add up to make sense to me. This time you're the specialist."

Gus grinned. "Then go ahead with the consultation," he advised. "I'm listening."

"They've been having even colder weather upstate," Doc told him. "Night before last it got down close to zero. That didn't bother me—I knew you had put plenty of anti-freeze in my radiator and, anyhow, I had my car safe in the hotel's heated garage."

"The bus was all right until I parked near the hall where the meetings were held. When I came out, it was all wrong—the engine acted as if it was starved for fuel. It was sluggish, had no power, and I couldn't get up over 30 in high gear, no matter what I did.

"I figured that probably moisture in the fuel bowl had frozen and was choking the carburetor—remember how you had to tow me home one bitter-cold night a few winters ago because of that? So at the first garage I came to, I stopped and asked the mechanic to check my fuel bowl. He did. There wasn't any ice in it. Then he checked the entire fuel line—even the fuel tank. Still no ice.

"About then the boss came over. He scratched his head for a while, and then came up with the opinion that the cold had hardened the lubricant around the spark-advance governor in the distributor so it wouldn't work properly. That sounded plausible—until a check showed that the lubricant hadn't hardened appreciably and that the governor was working normally.

"That made the boss scratch his head some more, and he went into a huddle with the mechanic. They came out of it with another opinion—that I'd better take my trouble to a carburetor expert down the street. I did, and he said that he knew exactly what it was—that a richer mixture was needed to give the engine normal power

Stan took the fuel pump out. "It's up to you," Gus said.



TO STAN HICKS

By
MARTIN BUNN

in such cold weather. So he put in larger jets. I paid him for the job—and before I'd driven a block the trouble had returned.

"Back in the hotel garage, I asked the foreman if he had any idea what could be causing the trouble. He said it might be the fuel pump, and he checked it while I was packing my bags and saying good-by to some of the fellows in the lobby. It was a couple of hours before I was ready to start for home. The foreman was just finishing and said everything was O.K. He was right—the car ran fine all the way home. It did this morning, too, until after I'd let it stand outside the hospital for three hours. Since then it's been acting up again."

"I'll have a look," Gus said. "Drive her in, Doc. No, never mind—the floor's too crowded. I'll check it outside." And he started for the door.

"Hold on," Doc called sternly. "You put a coat on. Think I want to have to try to keep you in bed for a week?"

Gus meekly did as ordered.

"There's no doubt about the engine not getting enough fuel," Gus said after he had

listened to it for a minute. "The job is to find out why it isn't getting enough."

He got out, raised the hood, removed the cover of the float chamber of the carburetor, saw that the chamber was only half full, and then checked the fuel pump.

"It looks as if your friend at the hotel garage had been on the right track, but he doesn't seem to have followed it far enough," Gus said. "There's something wrong with the fuel pump, all right. Its pressure is just about half what it should be. Stan!" he called, and Stan Hicks, the Model Garage grease monkey and budding young mechanic, came out into the cold air.

"Here's a simple little problem in applied automotive mechanics for you to solve," Gus told him. As directed, Stan took the fuel pump out. "It's up to you," Gus said.

Doc went off in a taxi, and Gus and Stan went back into the shop, taking the fuel pump with them. Stan put it on the bench, but had to take out the wrecker to haul in a frozen car before he could get to work on the pump.

An hour or so later, he took the pump





"At the first garage I came to," Doc recalled, "I stopped and asked the mechanic to check the fuel bowl."

apart, examined and cleaned each part, put it together again, and tested it on the bench.

"Hey, boss," he called. "I've fixed it. The pressure is all right now."

"Good," Gus said, coming over to the bench. "What was the matter?"

Stan looked blank. "I never thought of that. There wasn't anything wrong, I guess. Each part looked O.K. as I was cleaning it. There was one funny thing, though," he recalled. "The diaphragm was wet."

"Wet, was it?" Gus was thoughtful. Then he grinned. "Did you dry it off?"

"Oh, yes," Stan assured him. "But what goes on here, boss? Why was the pump bad when you checked it and all right after all I did was to take it apart and put it together again? It doesn't make sense."

"Yes, it does—if you throw in the fact that you took the wrecker out between the time you brought the pump in from Doc's car and the time you took it apart," Gus told him. "Results are what they pay off on, kid, and you got 'em—no matter how. It could be that you're a genius without knowing it." He gave Stan a friendly shove. "Put Doc's pump back in, and then apply your talents to one of these other jobs."

Doc Marvin hustled into the shop on the stroke of two. "I'm in a rush!" he called from the doorway. "Emergency call. Did you get the pump fixed, Gus?"

"Stan did," Gus told him. "He's good, Doc. In just an hour he'd diagnosed and cured a car ailment that is one of the toughest of any to spot. I just played second fiddle. But I'll tell you about it when you have more time. Your bus is outside, ready to roll."

"Good for you, Stan," Doc said hurriedly.

He sped away to answer the emergency call.

Stan scowled at his employer. "I don't mind being kidded when we're alone," he said, "but I don't think it's right in front of the customers."

"That wasn't kidding, Stan," Gus smiled. "Far from it. You did a real job. Of course, you don't know how you did it, but that happens to the best mechanics, and I'm not going to tell Doc that part of the story. What I was doing was building you up with the customer."

"Maybe I need building up with some of our customers," Stan grinned. "What was the matter with the pump, anyway?"

"You really should know," Gus said. "Remember that you went out with the wrecker after you'd brought the pump into the shop and didn't disassemble the pump until you got back about an hour later? That hour's wait in the warm shop was the cure, along with your wiping the wet diaphragm dry."

"If you had started on the pump as soon as you had it in the shop, you would have found ice on the diaphragm—enough to restrict its action. It's lucky the ice didn't puncture it—that can happen."

"Accumulated condensation inside the fuel pump was the underlying cause of the trouble, and when this cold weather came, the condensation froze. Of course, after the car had stood in a heated garage for a while, the ice melted, and the pump checked all right—the way it did in Doc's hotel garage—and there was nothing to show what had been causing the trouble."

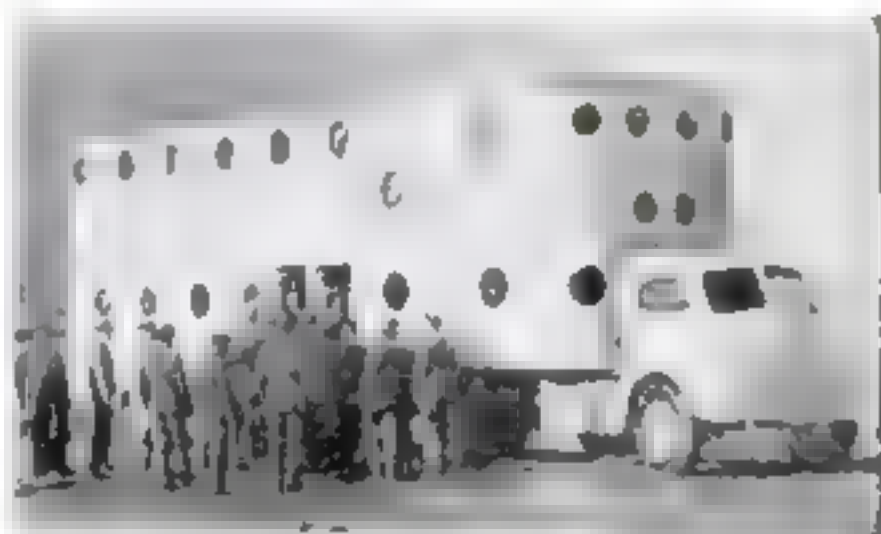
"If you hadn't been smart enough to notice that the diaphragm was wet, we'd probably be trouble-shooting the job yet. Nice work, Stan—and I'm not kidding."



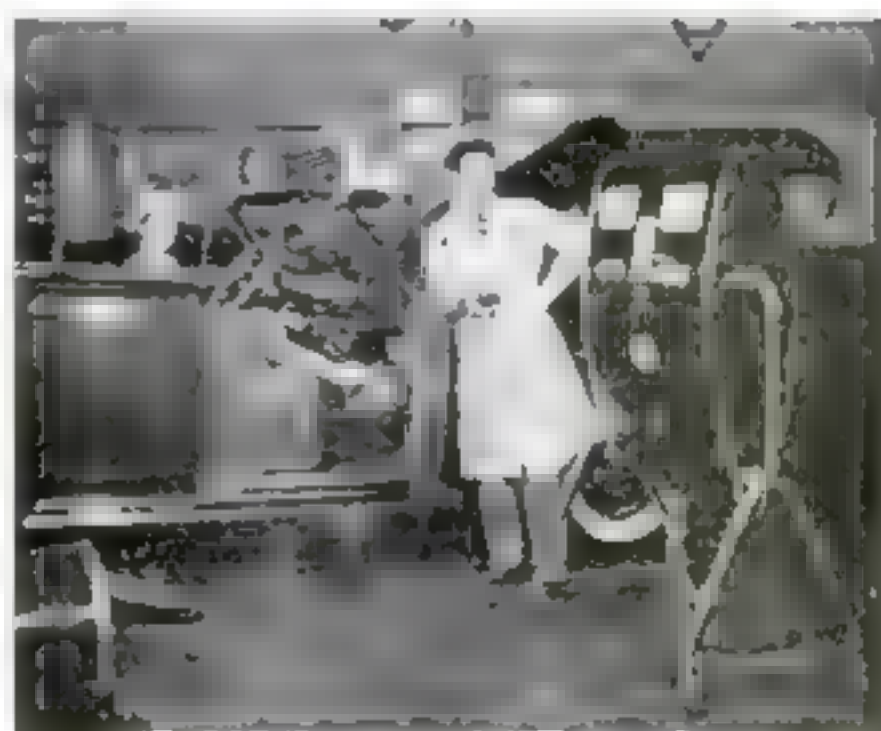
SNOW WEASELS, originally designed for Army use in Alaska, give promise of many civilian uses, particularly in mountainous regions. The U. S. Forest Service already is employing two for routine travel in the high Rockies. Other foreseeable uses include rescue of stalled motorists, carrying help to snowbound ranchers, and hauling feed to starving livestock in isolated grazing areas. Loaded to its capacity of 1,260 lb., this two-

passenger cargo carrier sinks only 18" in light snow, and even under the worst conditions it beats struggling along afoot on skis or snowshoes. Capable of speeds up to 25 m.p.h., it overcomes most difficulties of terrain, ambling up a 45-deg. grade and over vertical obstructions as high as 19". Although designed for snow travel, it fords rivers less than 44" in depth on its own power and in deeper water becomes a boat.

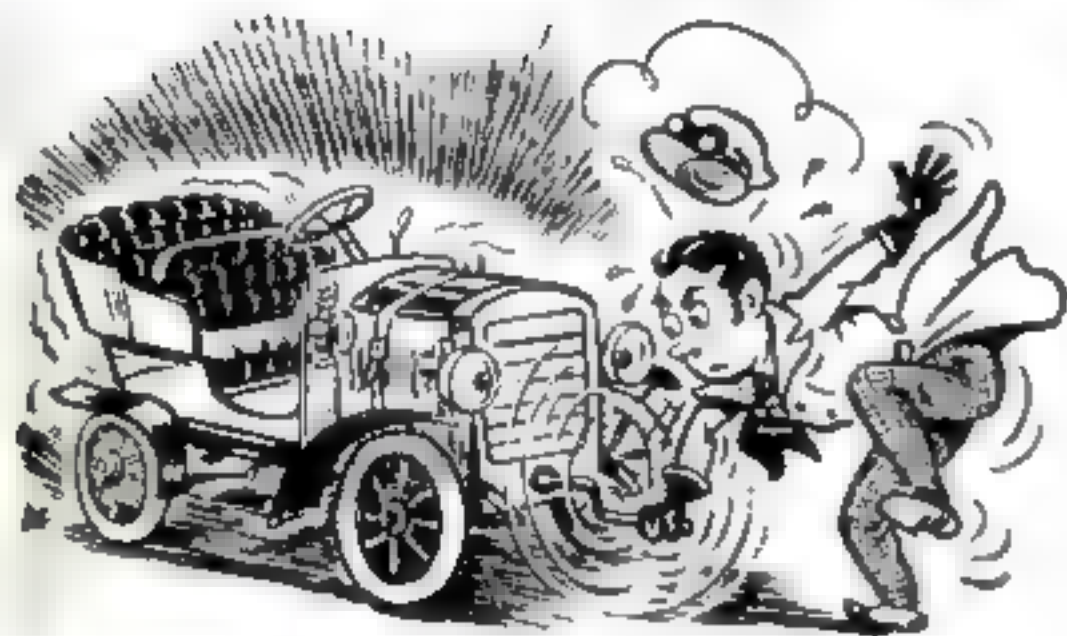
A GIANT BUS capable of carrying 250 persons, 100 seated and the rest standing, was built during the war by the White Motor Company for troop transportation in the wide expanses of an Army camp. With port-hole-type windows for both the lower and upper decks, the big transport looks like some fantastic land battleship. Although the vehicle is 15' high, the height is not particularly noticeable because the body is 2' wider than usual. The huge body was constructed on a rebuilt transport chassis.



CHECKING A CAR for defects in the power plant can be accomplished in five to eight minutes with the "Moto-Mirror," a dynamometer produced by the Clayton Manufacturing Company, of Alhambra, Calif., for service-station use. It consists of two major units, a cabinet containing recording instruments and a frame on which the rear wheels of the car are placed to operate transverse rollers. The frame embraces a hydraulic power-absorption unit fitted with solenoid remote-control valves, an electric induction tachometer, and a torque recorder. Simulating road conditions and testing the car throughout its driving range, the dynamometer indicates what adjustments are needed to bring the vehicle to top performance.



DON'T LET YOUR



Cranking a Horseless Carriage Was Quite a Task, but Modern Starters Seldom Let Us Down.

By WILLIAM H. CROUSE

IT WAS the year 1910. Henry M. Leland, head of the Cadillac company, was listening with interest as a young engineer talked about a better method of starting automobile engines. Some of the best engineering brains of that day already had wrestled with the problem, for hand cranking was at best uncertain and often dangerous.

What the young engineer proposed was revolutionary. He wanted to use an electric motor to do the cranking. He knew electrical experts claimed that an electric motor powerful enough to crank an automobile engine would be far too large and bulky, but he shrugged these calculations aside. After all, small electric motors could be overloaded for brief periods without damage to their windings.

The young engineer was C. F. Kettering, later vice president of General Motors and the famous head of its research laboratories. With Leland's backing, he developed an electric cranking motor, and by 1912 it was standard equipment on the Cadillac. To-day, an automobile without an electric cranking motor would be an oddity indeed. Before and since 1910, however, many other ideas were tried—the priming-pump starter, acetylene-gas starter, compressed-air starter, and mechanical spring-wound starter, to name only part of the list. But all of these were found wanting.

Mounted on the flywheel housing, the modern starter uses a drive pinion that meshes with the ring gear on the flywheel.

When a switch is closed, the battery spins the armature, and the drive pinion rotates the flywheel, starting the engine.

Since the gear ratio between the drive pinion and the flywheel is often as high as 15 to 1, the engine, after it starts, would spin the pinion and armature at ruinous speed unless provision were made for de-meshing the pinion without delay. Various automatic mechanisms are used to accomplish this. Two of the most common are the Bendix drive and the overrunning clutch.

A Bendix drive consists of two major parts, an externally threaded hollow sleeve attached to the armature shaft through a spiral spring, and a drive pinion with internal threads that match the sleeve threads, much as the internal threads on a nut match the external ones on a bolt.

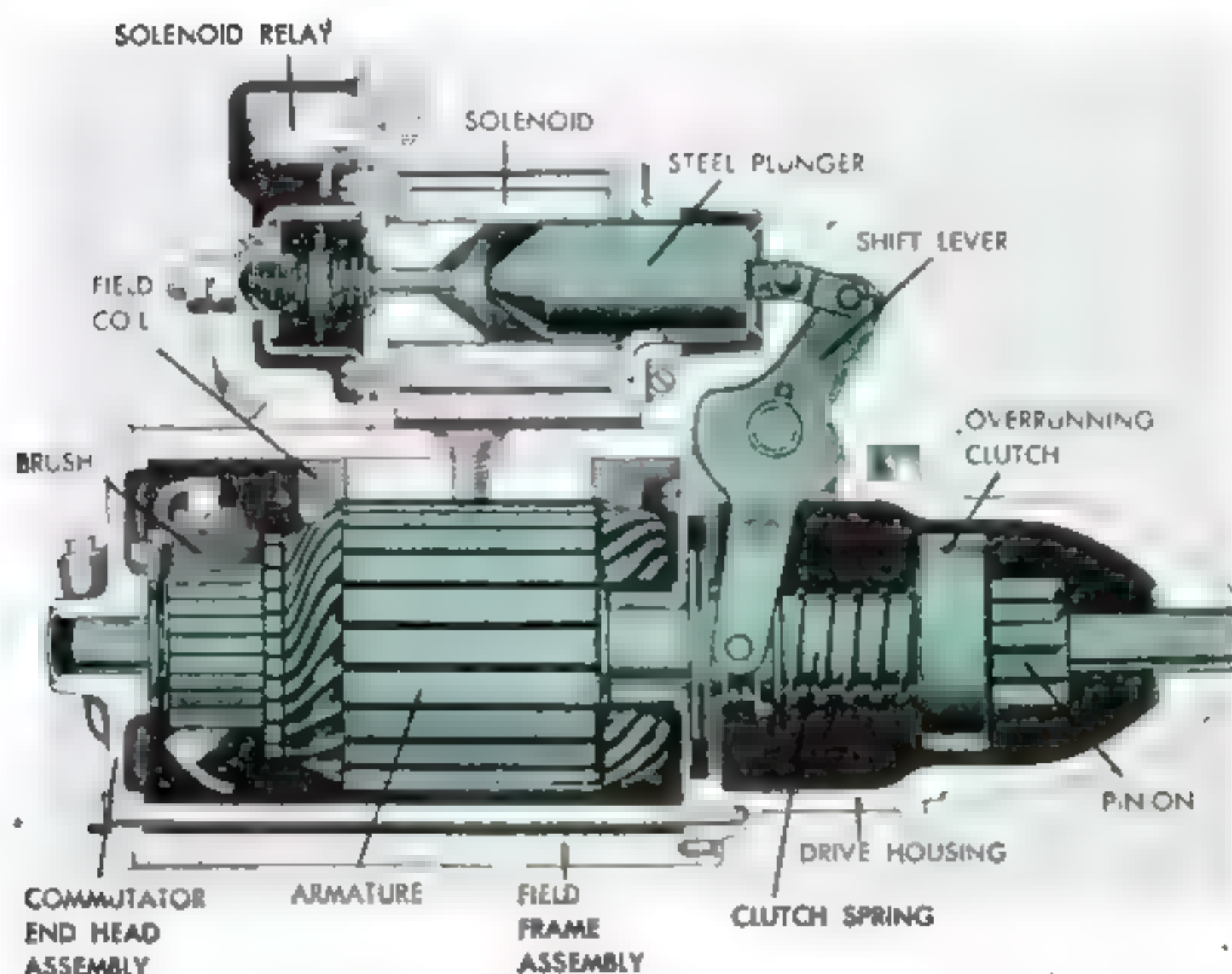
When the switch is closed, the armature and sleeve begin to rotate. Inertia, however, prevents the drive pinion from instantly picking up speed with the armature. As a result, the threaded sleeve turns within the pinion, forcing the pinion to move axially along the sleeve and into mesh with the ring gear, just as rotating a bolt in a stationary nut would force the nut to move axially on the bolt. The heavy spring, through which the cranking effort is carried from the armature to the sleeve and pinion, compresses slightly to take up the shock of meshing. When the pinion reaches the end of its travel, it is compelled to rotate as fast as the sleeve and armature. Consequently, the flywheel is turned and the engine cranked.

What happens when the engine picks up speed and spins the drive pinion faster than the armature and sleeve can be visualized by thinking again of the action of a nut

Hand-operated priming pumps were an early form of self-starter, but they were not much of a success.



STARTER STOP YOU



In this cranking motor, a solenoid operates the shift lever that moves the overrunning clutch into mesh.

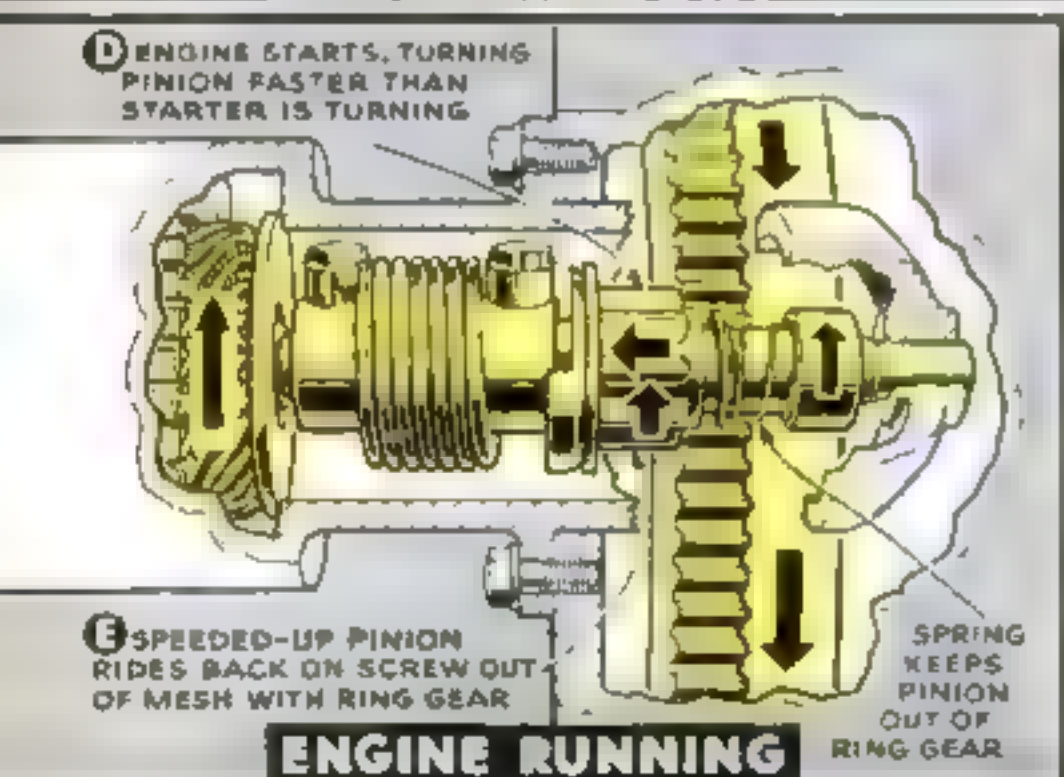
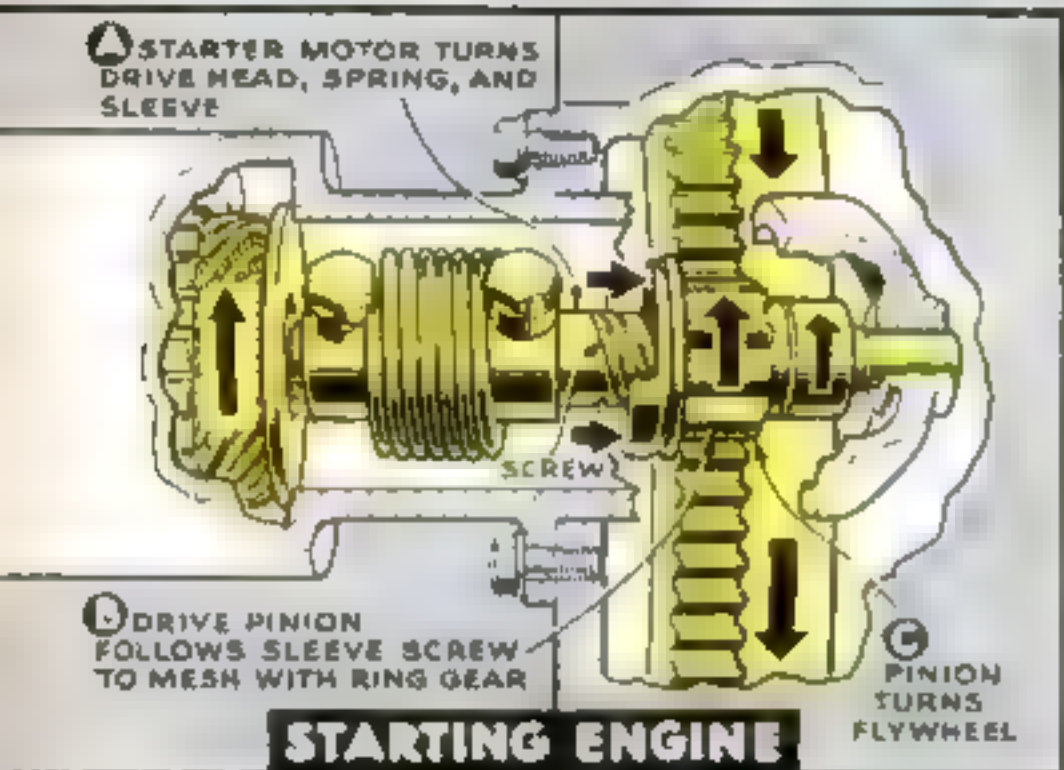
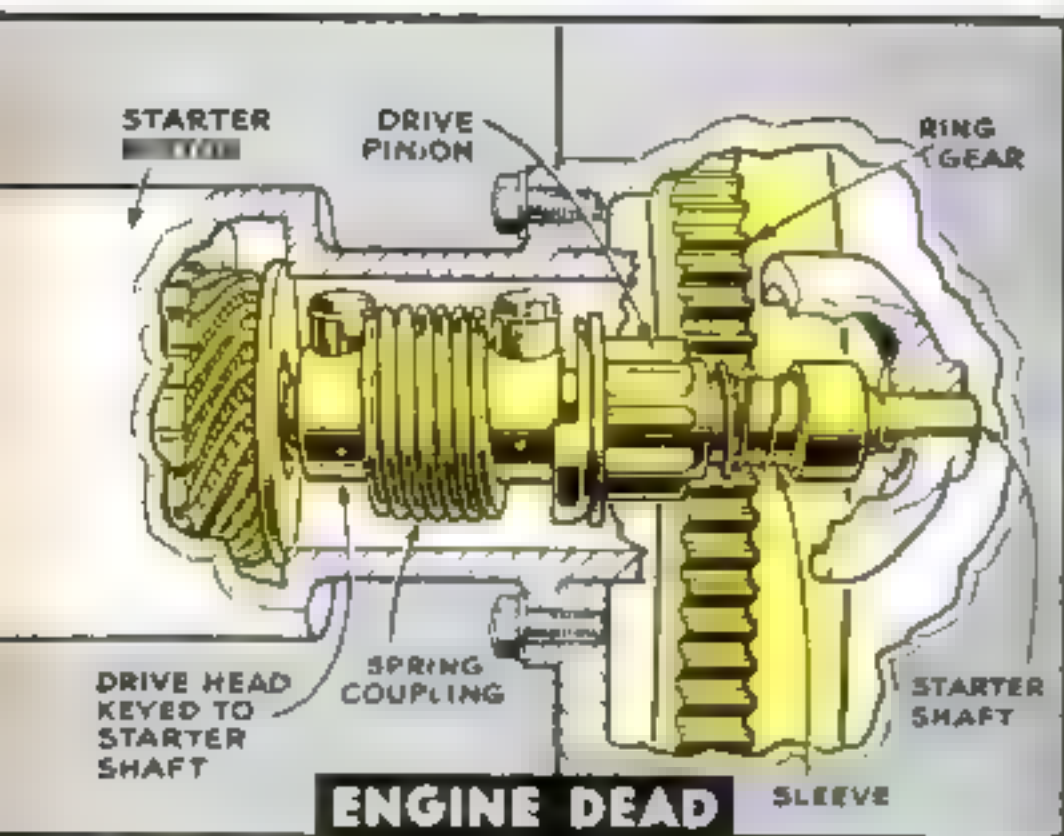
and bolt, the nut and bolt in this case both turning in the same direction but the nut much faster than the bolt. Since we have seen in the preceding paragraph that the nut moves axially in a certain direction when the bolt is turning faster than the nut, the nut must now move axially in the opposite direction. This is exactly what happens when the drive pinion begins to turn faster than the sleeve. The threads automatically throw it out of mesh with the flywheel. An antidrift spring keeps the pinion, when at rest, from slipping into mesh while the engine is running.

Although the principle is the same, not all Bendix drives are alike. Two general classifications are produced—the inboard type, in which the pinion must move toward the armature to mesh with the ring gear, and the outboard type, in which the movement is in the opposite direction.

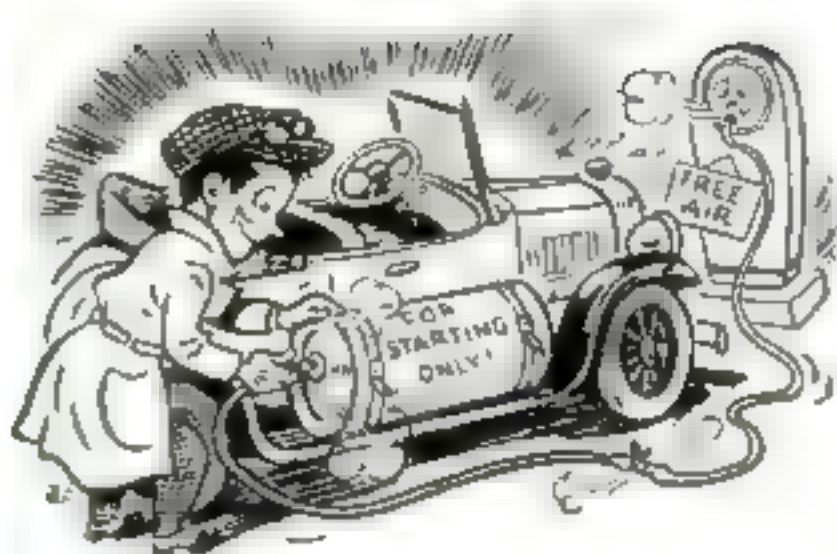
When a cranking motor fails to function properly, removal of the cover band will permit inspection of the brushes and commutator, as indicated here.

Instead of withdrawing the drive pinion from mesh as the engine starts, the overrunning clutch drive permits the pinion to overrun, or run faster, than the armature. When the engine is to be started, external straight splines on the armature shaft and





Matching threads on the sleeve and in the drive pinion give a Bendix drive an action similar to that of a nut and bolt. As the motor whirls the sleeve, inertia keeps the pinion from coming up to speed at once, so the screw action moves the pinion sideways—into mesh. When the engine starts, the pinion turns faster than the sleeve, so screw action moves the pinion out of mesh.



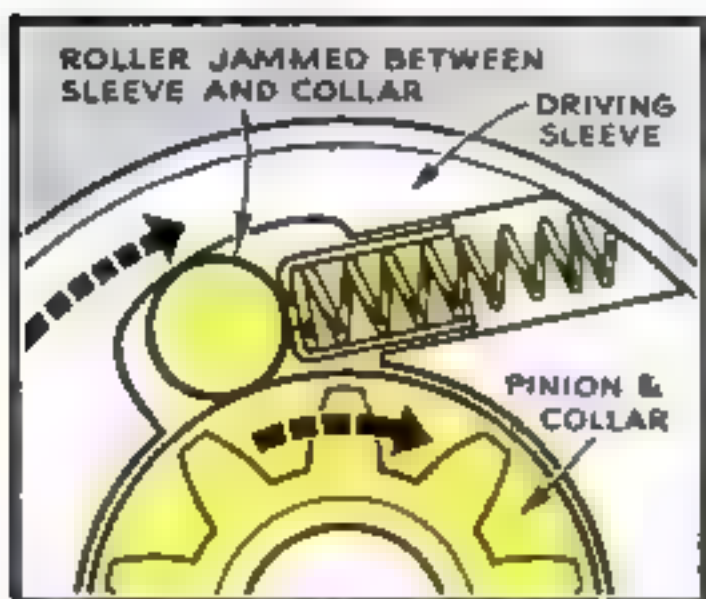
Some drivers in the olden days had to wrestle with self-starters operated by compressed air.

matching internal splines in the pinion allow a shift lever to force this gear axially along the shaft and into mesh with the ring gear. The lever is operated either by linkage from a foot pedal or by a solenoid on the cranking motor.

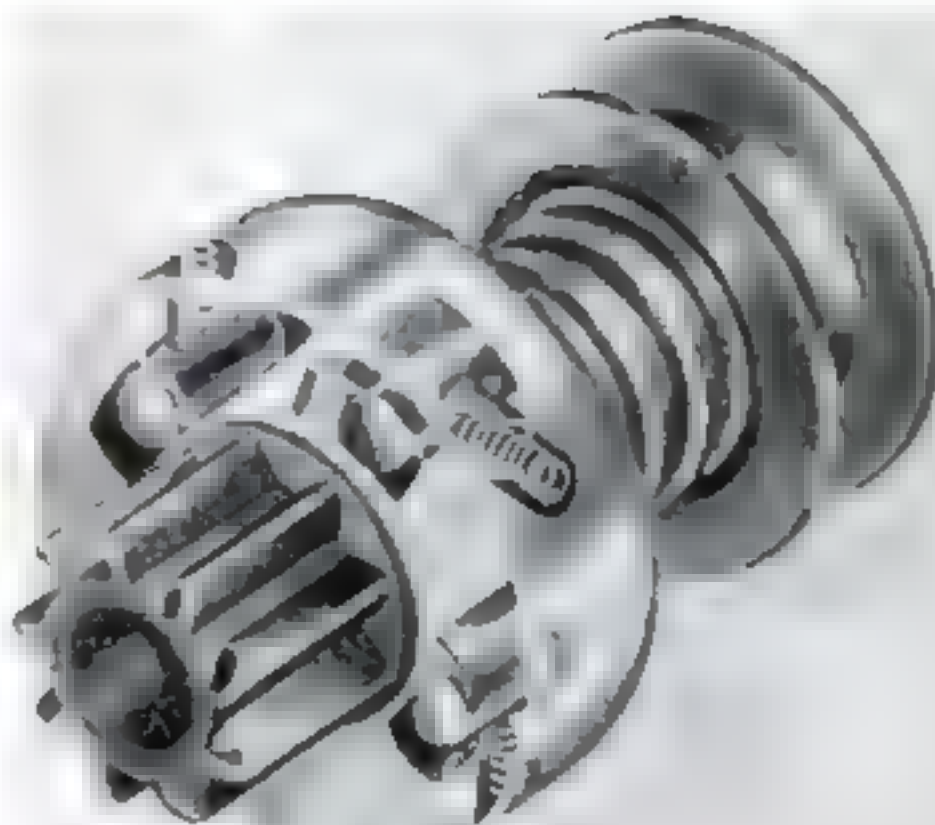
As the lever completes its travel, it closes a switch and cranking takes place. If the pinion and ring-gear teeth should butt instead of meshing, a spiral spring between the shift-lever collar and the clutch compresses, then snaps the pinion into mesh when the armature rotates. When the lever is released after the engine starts, a spring returns it to the idle position and also pulls the pinion out of mesh.

An overrunning clutch consists of an outer shell, with four notches into which four steel rollers are fitted, and the pinion and collar assembly. The notches are shallower at one end. When the armature and outer shell begin to rotate, the four rollers jam in the smaller end of the notches, forcing the pinion and collar assembly to rotate. As the engine starts, it drives the pinion faster than the armature is rotating. The rollers move into the larger end of the notches, where they cannot jam, and the pinion and collar assembly overrun, or rotate faster than, the outer shell and armature.

On many cars, starting is accomplished with a foot pedal or switch, but others have systems that start the engine automatically when the ignition switch is turned on and the accelerator pedal is depressed. Such systems use a magnetic switch or solenoid mounted on the cranking motor, plus a vacuum switch linked with the accelerator pedal. Thus, depressing the accelerator pedal for starting closes an electrical contact in the vacuum switch and, if the ignition switch is on, a circuit is completed between the battery and solenoid. The solenoid then



When the engine starts, an overrunning clutch permits the drive pinion to run faster than the armature. Four rollers operating in notches in the outer shell produce this action. When the armature turns, the rollers jam into the shallow ends of the notches, forcing the pinion and collar to crank the engine. As the engine starts, the rollers automatically move to the end where they cannot jam.



closes the starter circuit—and cranking takes place. When the engine starts, a vacuum develops in the intake manifold. This actuates the vacuum switch, the solenoid is disconnected from the battery, and the cranking motor stops.

Now that we have had a general look at the operation of the cranking motor, we come to the question of what we can do about it when the engine refuses to start. Starting complaints can be divided into three general groupings: the engine cranks normally but does not start, engine cranks slowly but does not start, and engine does not crank at all.

When the engine is spun at normal cranking speed but does not start, the trouble undoubtedly lies elsewhere than in the starter.

At low temperatures, slower cranking is to be expected, for the engine lubricating oil is much heavier, the engine is stiffer, and the battery is somewhat less efficient. If, considering the temperature, the cranking speed is excessively low, check the battery with a hydrometer. If the battery is in good condition, the cables and connections should be examined for broken or frayed strands that might not allow sufficient current to flow. If these seem in good order, remove the cover band from the cranking motor and observe whether the brushes and commutator are worn or dirty.

If there is no response at all when the cranking motor switch is closed, the headlights may give a clue to the trouble. If they do not burn, or burn only dimly, the battery is probably run down. If the lights burn at more or less normal brilliance, they

will do one of three things when the cranking motor switch is closed: go out, dim considerably, or continue to burn brightly.

When the lights go out, there may be a bad connection at one of the battery terminals. In such cases, the connection sometimes may be improved sufficiently for emergency starting by swinging the cables back and forth on their terminals. If the lights dim considerably, the battery probably is in a low state of charge, but if it is not, some difficulty in the cranking motor or engine should be suspected. In the engine, such conditions as tight or stuck pistons may prevent cranking. If the lights stay bright, there probably is an open circuit in the starter wiring.

Spring-wound mechanical starters may never have done this, but the motorist never was quite sure.





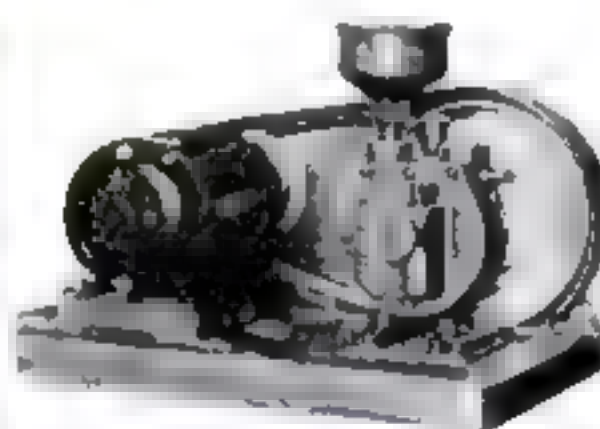
CONCRETE BALLOONS that helped to solve a war-housing shortage may have a chance to fill the same need during peacetime. These structures, erected by spraying concrete on inflated balloons and then removing

the balloons, have housed Goodyear workers at Litchfield Park, Ariz. Wallace Neff, Los Angeles architect, proposes such designs as the double connected dome at left above and the single dome at right.



NO COAL SHORTAGE HERE. When he gets ready to fire his furnace, all W. B. Swope ever has to do is to go to the back yard of his home at Welch, W. Va., and dig up a few shovelfuls of coal. He—fortunate man—has his own private 300' bituminous coal mine with an opening only 25' from his back door. Here he is shown filling a wheelbarrow with enough fuel to keep the furnace going all day. No, sorry, mines like his aren't being manufactured for general sale. But at least it is comforting on these chilly days to know that some people have no difficulty in keeping warm.

FIRE RETARDING characteristics are claimed for a new chemical product that is sprayed or brushed on like paint and is available in a variety of colors. Supplied as a powder, it is mixed with water for application on walls, ceilings, wood beams, and insulation panels, and may be used on garages, farm buildings, boats, trailers, planes, and the like. Albi Chemical Company, of Chicago, the manufacturer, says that the coating becomes a cellular mat or blanket when exposed to flame and protects the surface it covers. The Underwriters' Laboratories, Inc., reports that tests show it retards burning in red oak by 50 to 70 percent.



HEAT IN RADIATORS is assured by a vacuum-pump unit made by Leiman Bros., Inc., of Newark, N. J., that converts ordinary steam heating into a vacuum-steam system. Return pipes to the furnace boiler may be connected from all radiators, or they may be necessary from only one or two that offend regularly by collecting air pockets.

BOY'S ICEBOAT GOES LIKE THE WIND

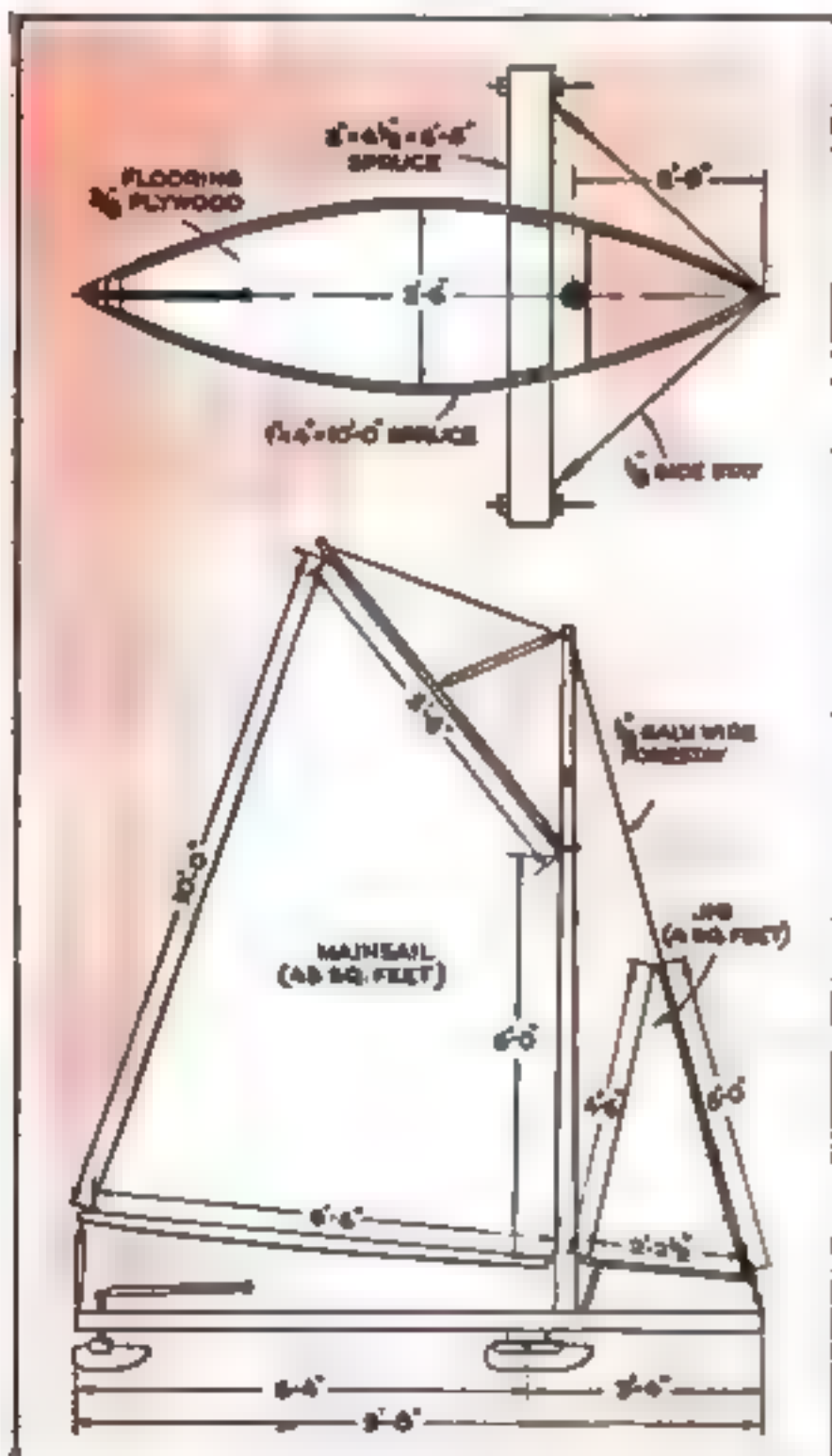
By Richard C. Clapp



ALTHOUGH he was not yet quite six, my son David sailed this little iceboat all last winter with great success. Faster than many boats with larger sails, it would delight any youngster. When we load it on the car and go to the river, there never is any lack of boys asking for a sail.

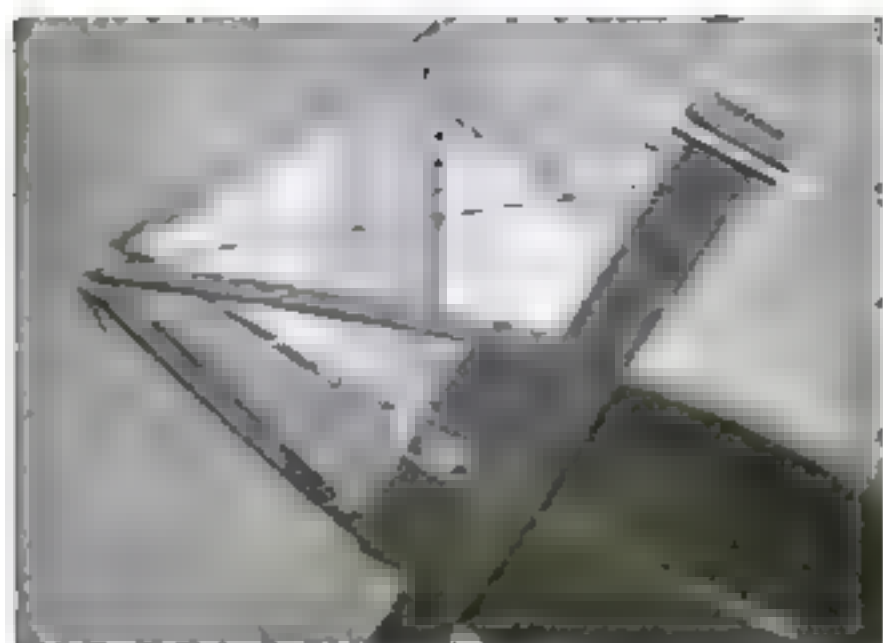
Any good craftsman, even if he is a beginner in iceboating, should have no difficulty building the boat. The necessary materials are found in most workshops or, if not, can be bought at little expense. Some substitutions may be necessary, but builders are urged to stick closely to the stated dimensions, since the boat has been tried and proven. If a secondhand sail is available, the entire job can be done for less than \$20. Even with a new sail the cost should not exceed \$35.

Before beginning the frame, form the metal bow and stern plates, as shown in the drawings, and cut the triangular stern block



Easily handled by any red-blooded youngster, this trim little iceboat is fast—but safe. To shape the frame, temporary spreaders are used. Notice that sail dimensions are given in the side view.





Although the plans specify an oak block, a metal bracket may be attached under the mast as above.



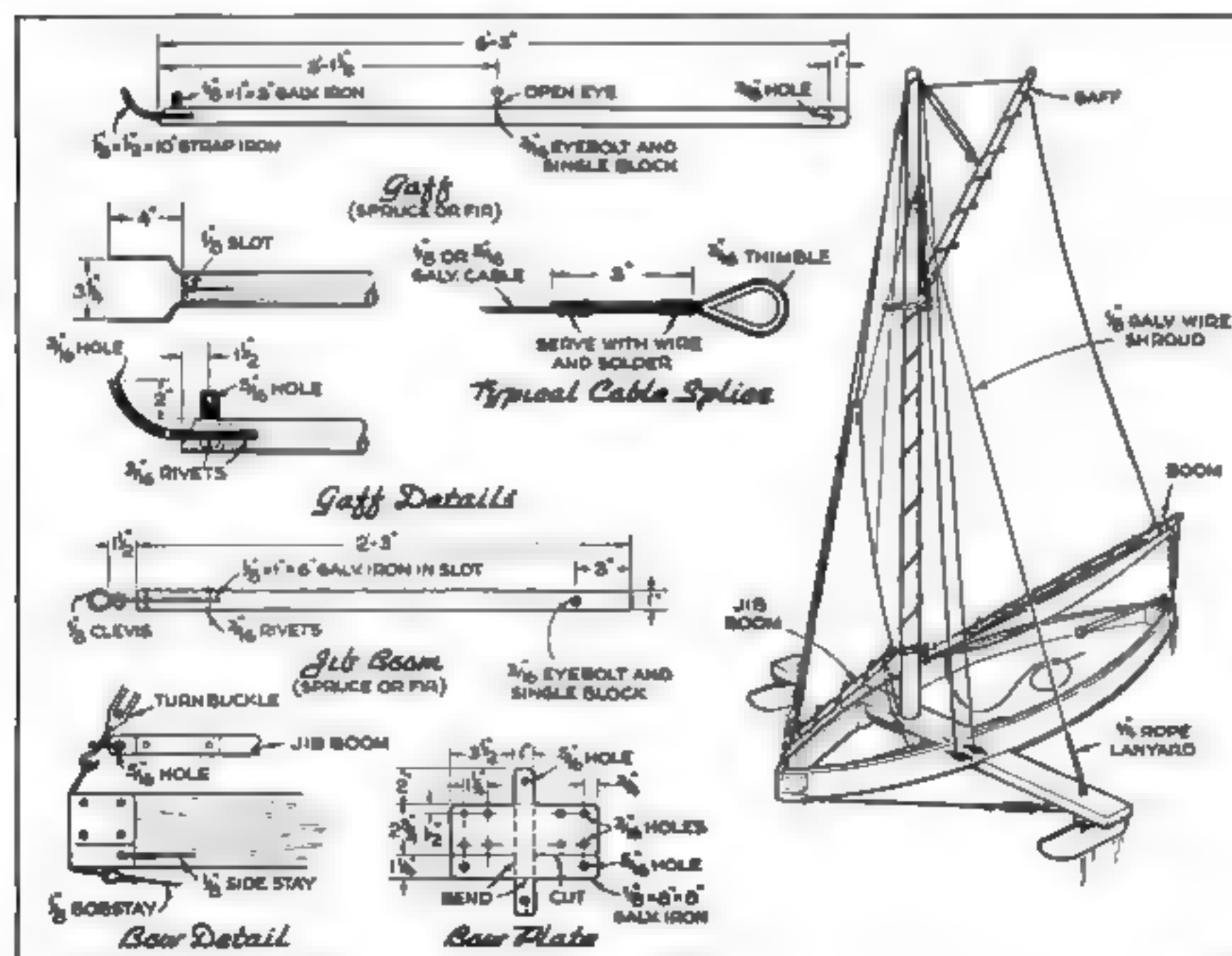
Pivoted runners give more speed. Two cleats seen on the frame hold the ropes that raise the gaff.

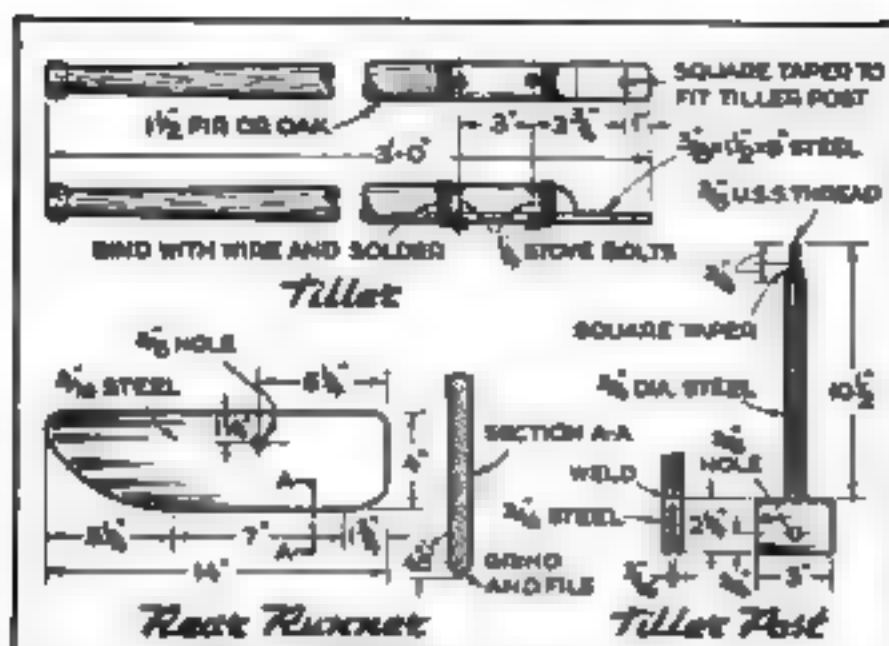
from a piece of oak, being careful to center the $\frac{3}{4}$ " hole for the tiller post and to drill it vertically. Then spike the two 10' sides to the block and attach the stern plate with 2" wood screws. In shaping the frame, a spreader will be required at the center and possibly one or two on each side. It may be necessary to call in a neighbor to help you draw the bow together and attach the bow plate.

Install the flooring before removing the spreaders, fastening with $1\frac{1}{2}$ " wood screws. Although $\frac{3}{8}$ " waterproof plywood makes

the best flooring, solid boards can be used.

The mast is stepped on a plank cut to length from a 2" by 6" piece of spruce. This fits in mortises in the upper edges of the two 12" spruce or pine pieces bolted to the frame. Spikes driven through the frame and into the ends help keep the step from twisting when the mast is in place. One 20-d. nail for holding the mast is driven into place before the 2" by 5" by 6" oak block is attached under the step. If you prefer, a metal brace can be used instead of this block, as on the original boat.

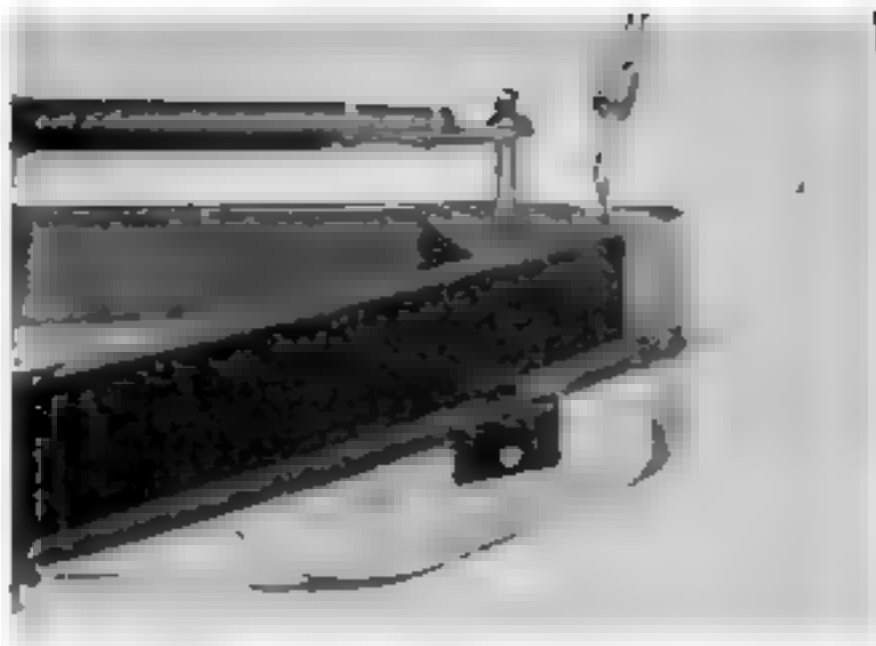




Since some shearing and welding are needed, it may be best to have a local shop make the metal parts.

Steel plate for the runners should be obtainable at any large machine shop. If possible, have the runners sheared to approximate shape there. Then grind to final shape on a coarse-grit grinding wheel and finish with a fine mill file. Each running edge should be finished to a 45-deg. angle.

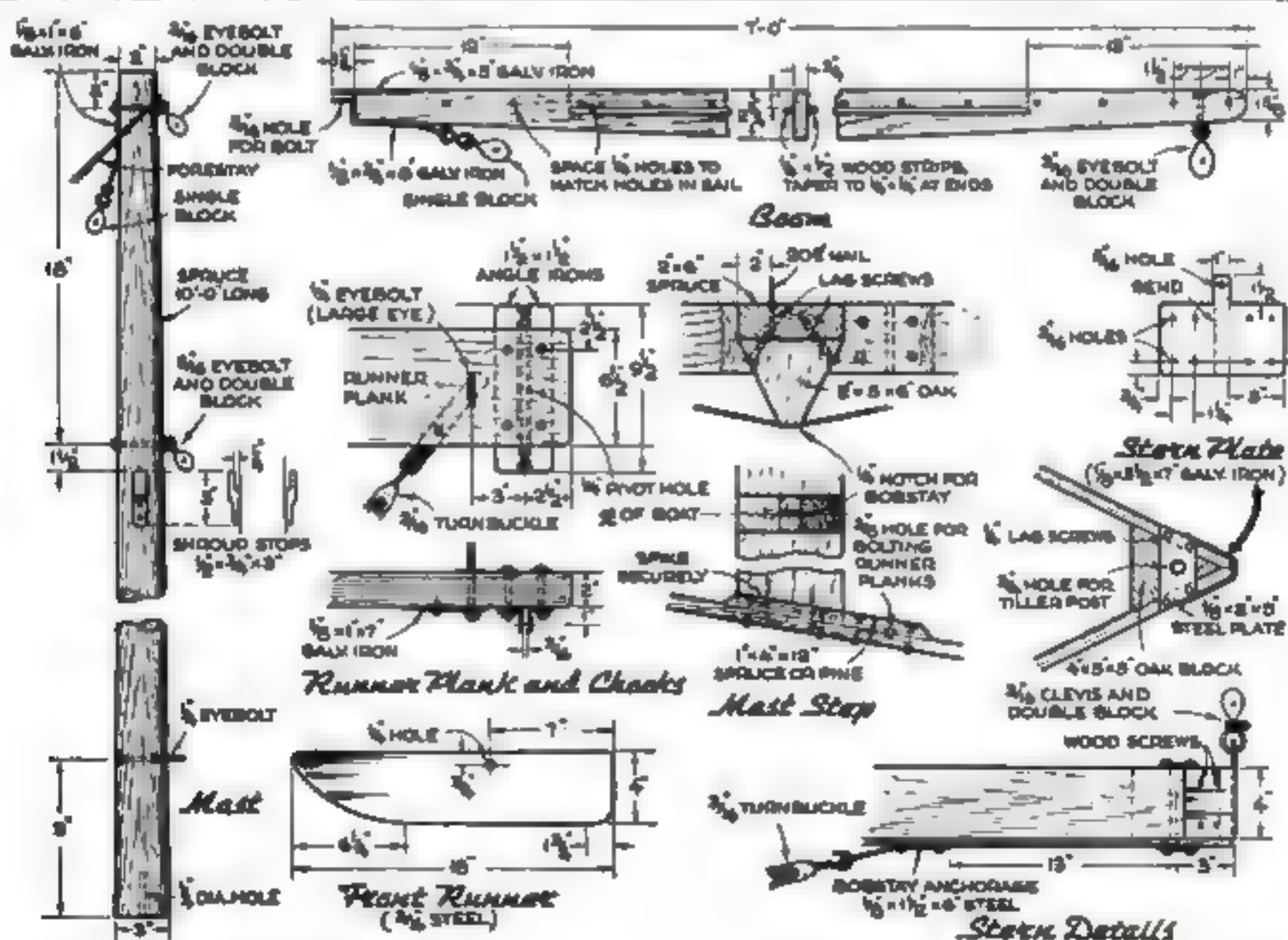
The speed of the boat will be in direct proportion to the accuracy with which the front runners are lined up. After cutting the runner plank to length, clamp on the angle-iron pieces that form the chocks, place the runners in the chocks, and square

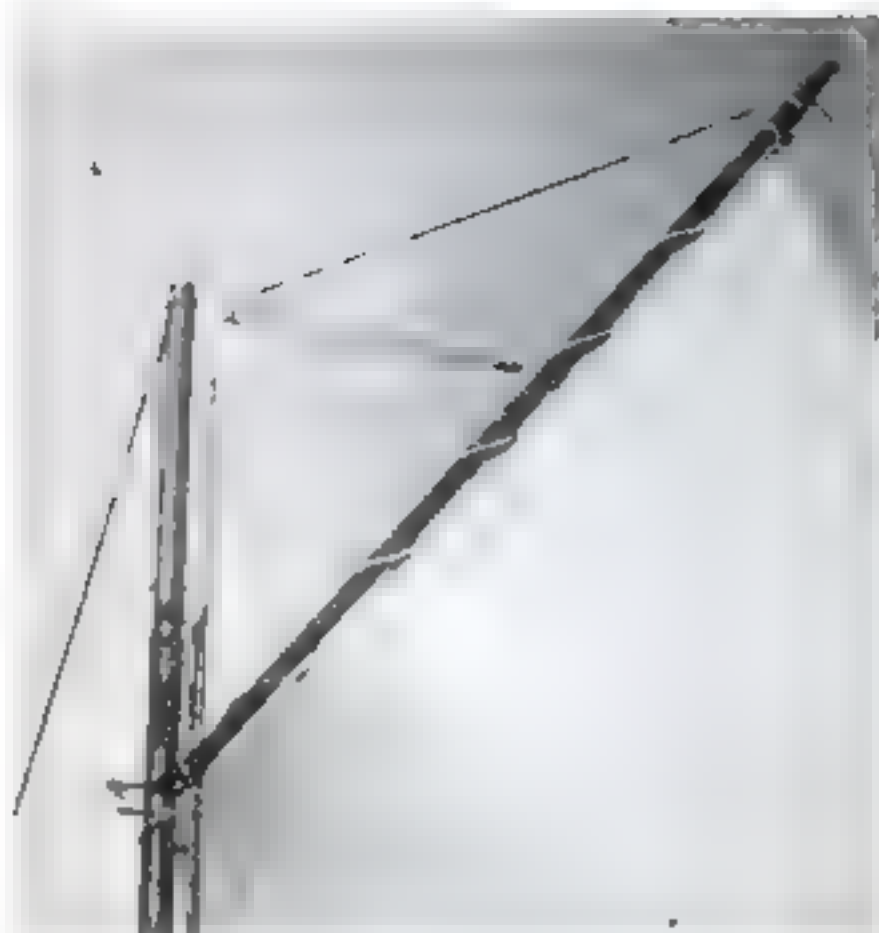


In the original boat the sheet block was attached as shown here. The drawings give a simpler method.

all up on the plank by using a carpenter's square. Then across the cutting edge of both runners at the back lay a stick of stock about 7' long and exert pressure to cause a slight impression in the wood. Next place the stick across the runners at the front, and, if the runners are parallel, the depressions in the stick will fit over the cutting edges in that position.

Proper squaring and centering of the runner plank on the frame is another important factor in the success of your boat. Mark the centerline of the plank both as





Mitched to the peak of the gaff, the peak halyard is rigged through two blocks, then down to "deck."

to length and width and place a small brad at the point where the two lines cross. Then center the plank on the frame by aligning this point on a cord strung from the bow to the stern. Check for squareness by measuring from the tiller-post hole to the same point on each runner chock. When you feel certain everything is square, drill $\frac{3}{8}$ " holes through the plank and frame and fasten with $\frac{3}{8}$ " carriage bolts.

Like the front pair, the rear runner should have a slight rocker effect for smooth operation of the boat.

You will need 50' of $\frac{1}{8}$ " or $3/16$ " stranded galvanized wire for the shrouds and stays. If stranded wire is not available, $\frac{1}{8}$ " solid wire will do, although it doesn't give as finished a job. In attaching the bobstay, note that the rear anchorage is centered under the flooring.

Turnbuckles are of the dime-store variety.

Here's the way the jib is attached. A clevis on the fore end of the boom rides on the turnbuckle.



Looped around the mast, the shrouds help hold it upright. The jaws of the gaff straddle the mast.

Rope is used instead of turnbuckles to fasten the side shrouds to the runner plank, for this will ease the shock when a gust of wind hits or a runner lifts. Awning pulleys will serve for the blocks, five singles and five doubles being required. If the necessary 150' of $\frac{1}{8}$ " manila rope is not obtainable, $\frac{1}{8}$ " jute will be adequately strong.

The mainsail is laced to the gaff and boom before being raised, and both spars are removable along with the sail. In rigging the sail, note that ropes which raise the peak and throat of the gaff are secured to cleats on the side of the boat, and that the rope to the jib is tied to another on the opposite side. If you should want to make your own sail, see P. S. M., July 1939, p. 160, or May 1940, p. 176.

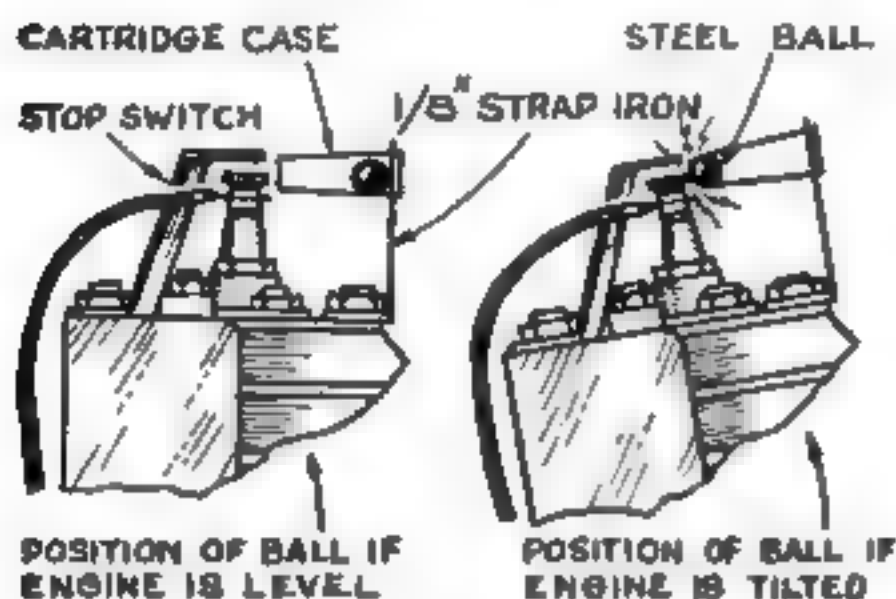
Varnish or paint will complete your boat. On this one, the frame and plank are Chinese red and the spars are black.

Note how a bolt holds the boom to the mast. Both the boom and the gaff are removed with the sail.



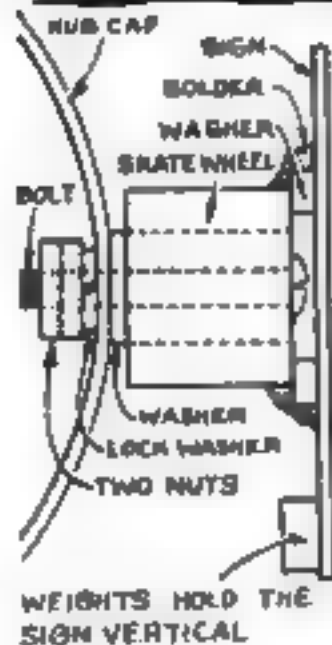
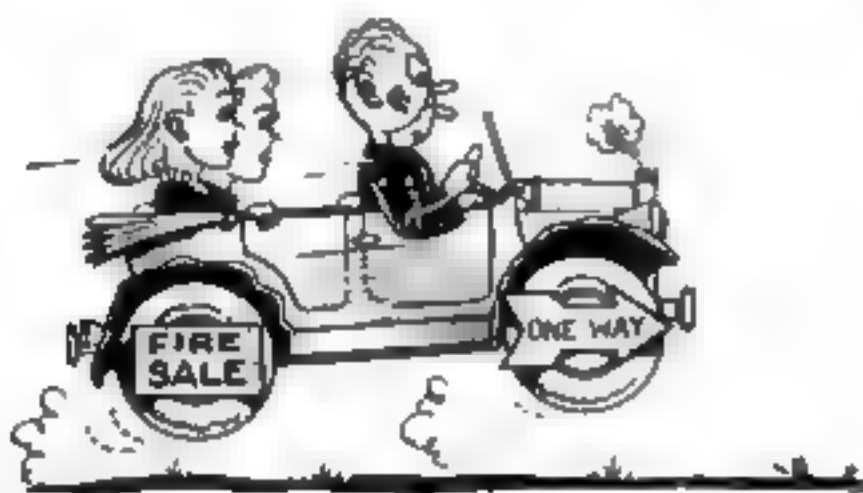
WHAT'S YOUR **INGENUITY** QUOTIENT?

Have you pulled off a smart one lately? We will pay for each contribution accepted for this page showing ingenious solutions of problems in the home, shop, garage, or camp. It doesn't matter if it's wacky—if it works.



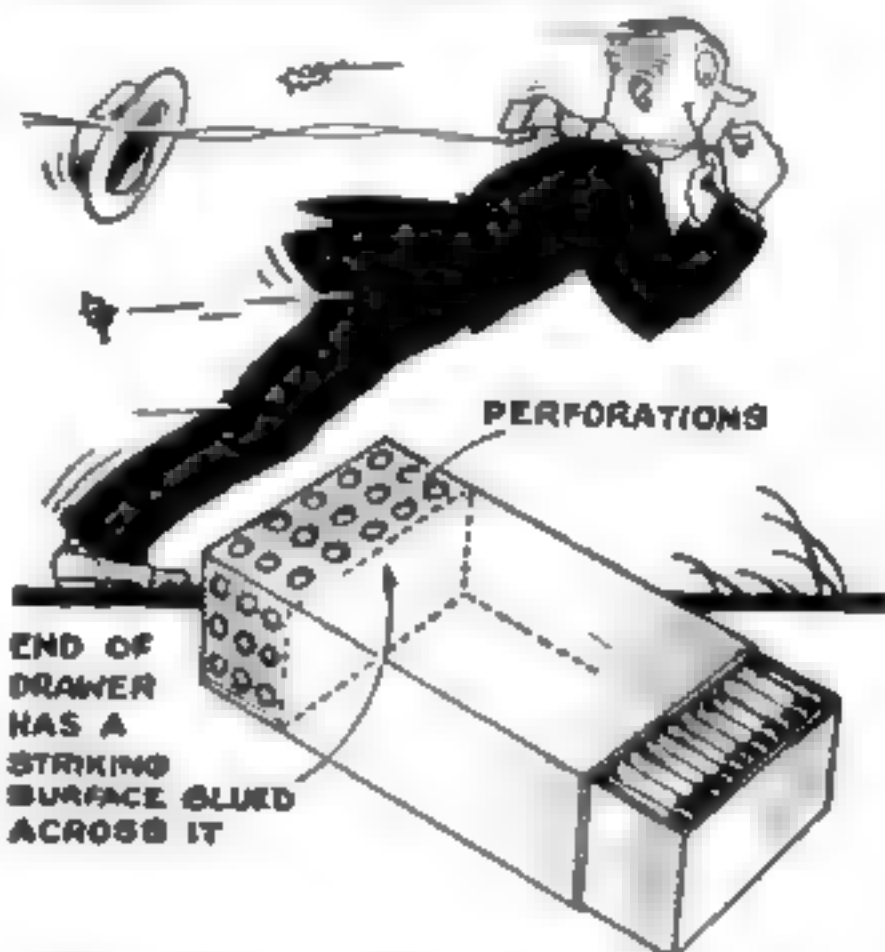
PINBALL MACHINES have a way, when you get too ambitious, of lighting up like a flame thrower, sounding a 21-gun salute, and snarling back the big letters "TILT!"

This protective behavior suggested to me the notion above. GI's in my outfit often trundled our portable air compressor about with the engine running. Oil wouldn't feed on the tilt and *blam* would go the main bearings. With my pinball special, the engine stops dead if some unwary soul tries to move it when it's going. A steel ball runs down a .45-cal. cartridge case and shorts the spark plug.—SGT. J. MOONEY.



CAR CARDS are usually placed near the roof of a bus, but not in my bus. I got right down to earth with my homemade advertising, attaching signs to all four hubcaps by means of the skate-wheel arrangement shown at the left. Weights on the placards, plus a little lubrication, keep the signs upright as the car rolls along.—P. L. SIMON.

WHEN THE WIND BLOWS, so do my matches. At least they did before a strong wind blew this idea into my head. I took the outer sleeve of a matchbox, perforated it at one end as shown in the drawing, and glued a striking surface across the outside end of a drawer. Now I just dip a match into the recess, and—presto! Zippo! Poof! Sorry, you'll have to poof harder than that. These matches stay lit.—NEVEN JONES.

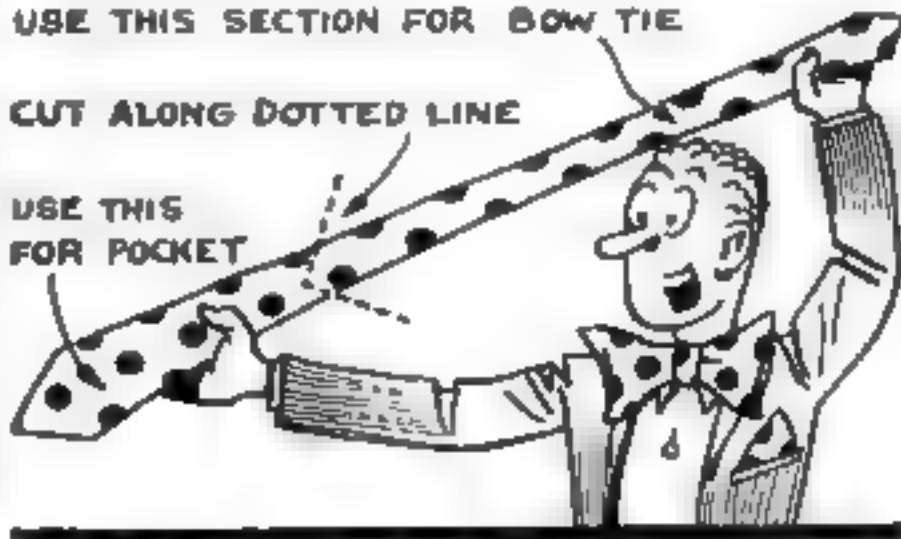


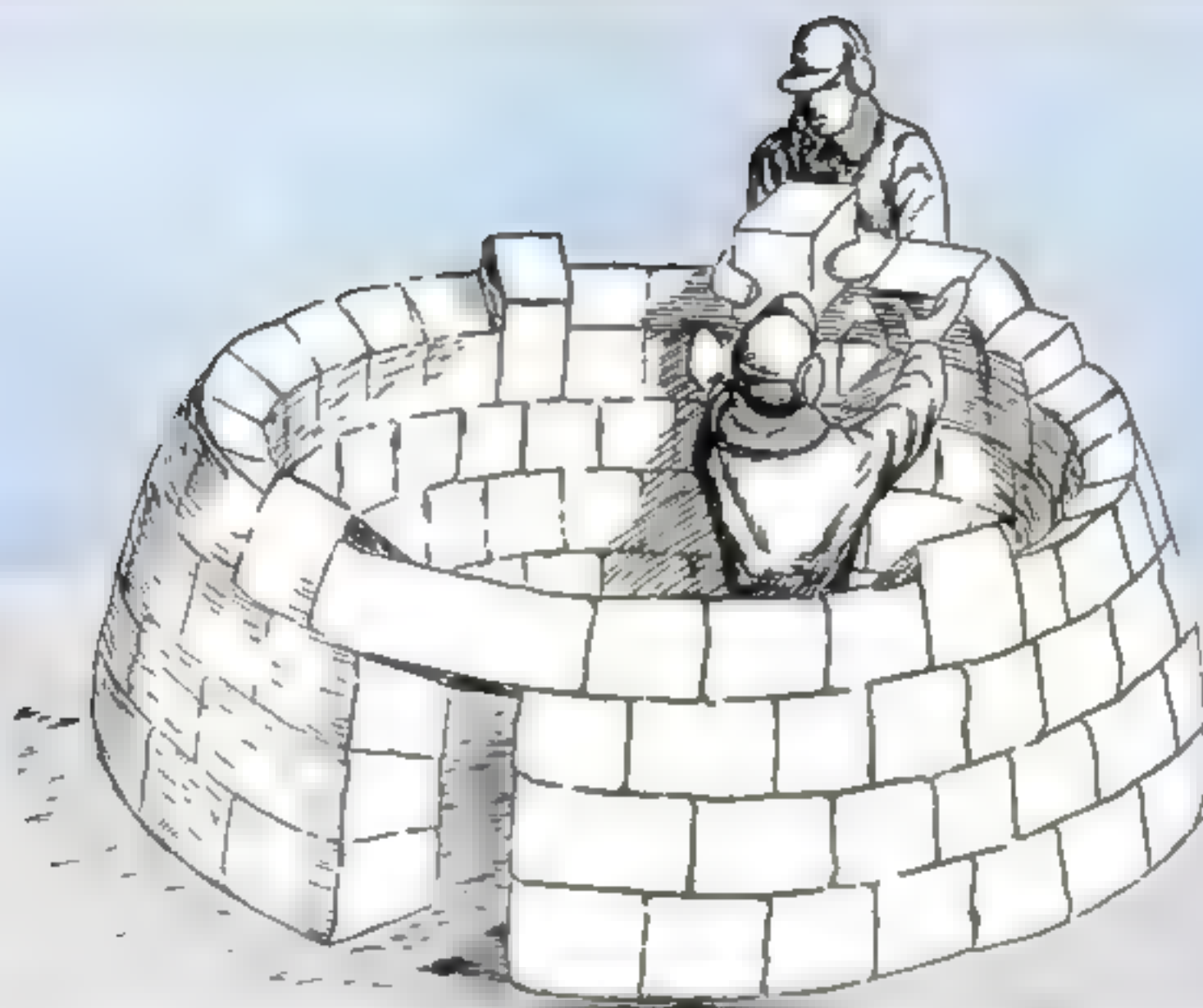
CAN YOU TIE THIS? When I get tired of a four-in-hand necktie, I cut it into two parts to make a bow-tie and display-handkerchief ensemble. The wide end, snipped off just below the grease line, dangles very handsomely from a breast pocket while the other part continues to protect my Adam's apple from the elements. And—would you believe it?—the two parts of my new ensemble match perfectly.—J. N. PARKER.

USE THIS SECTION FOR BOW TIE

CUT ALONG DOTTED LINE

USE THIS FOR POCKET





SNOW IGLOOS FOR WINTER FUN

WHEN you get a really heavy snow, or a succession of snows packs to a 10" or 12" depth, why not try your hand at building a back-yard igloo? Small children will love playing Eskimo in it, while older ones will use it for anything from a "hunting lodge" to a clubhouse. If you want to save yourself some of the heavy work, it might be a good idea to organize a gang of youngsters to help in the construction. At any rate, provide a sled or two to haul the blocks to the building site, for this chore proves very tiring after you have carried several dozen blocks from your snow "quarry."

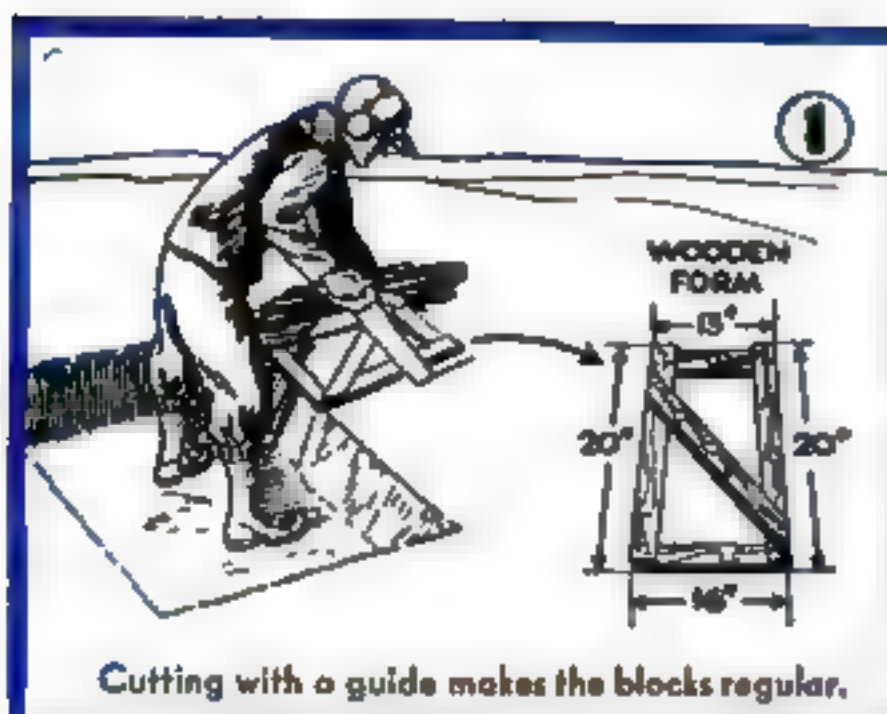
Drive a stake at the center of the igloo location; then with a line tied to the stake at snow level mark off circles of 6' 4" and 8' radius to designate inside and outside wall surfaces. The site must be leveled and soft snow packed down or removed. If the snow is deep and well packed, the lower part of the igloo interior can be dug out and the dome built over it.

The snow blocks are cut from the sides of a pit having vertical walls 12" to 20" deep, as in Fig. 1. Stand in the pit and cut the blocks from the edges, making the side sur-

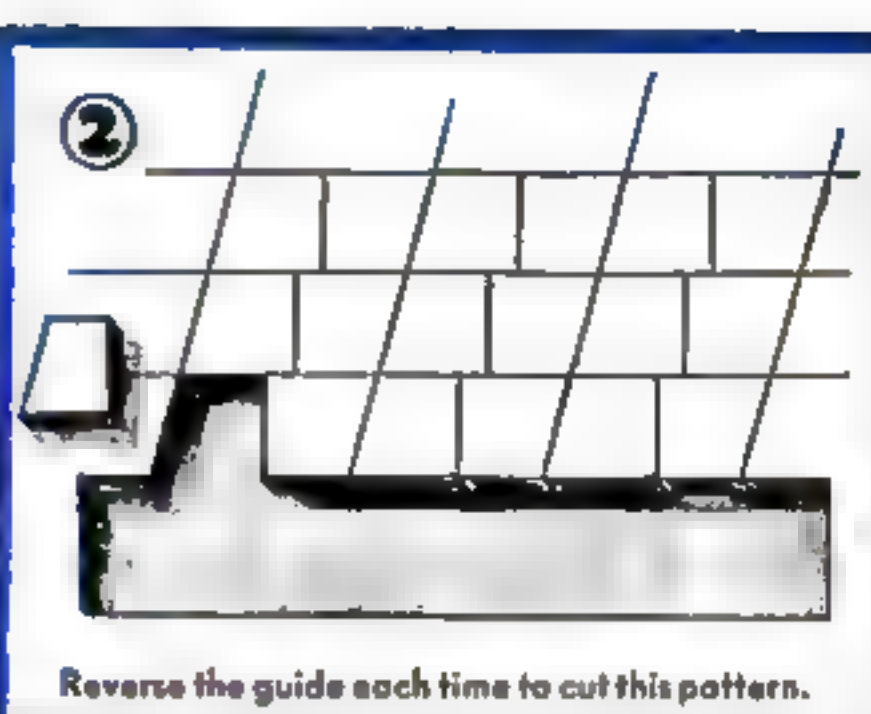
faces perpendicular. It will be a help to use a guide made of scrap wood, as shown. One of the long sides should be square with the two parallel ends and the other at an angle in order to make blocks shaped like those in Fig. 2. The slanting surface of the blocks becomes the top of each tier, and their slope forms the dome naturally.

Place the blocks in a circle, as in Fig. 3, pressing them as close together as possible for firm construction. Apply your measuring line from time to time to be sure all tiers are the same distance from the center, as indicated in Fig. 4. If you note any tendency of the blocks to slip on the higher tiers, wedge in a few double-height ones to serve as keys, as shown in the large drawing above. Space for a doorway is of course left in the foundation. Extra-length blocks above it at about the fourth or fifth tier will provide strength for holding the dome at this point. On completion freeze the igloo for a height of about 4' by sprinkling it with water, but leave the outside rough to catch new snow and gain added strength.

Keep the inside smooth so melted snow will run down the wall instead of dripping. When it becomes glazed, scrape it and



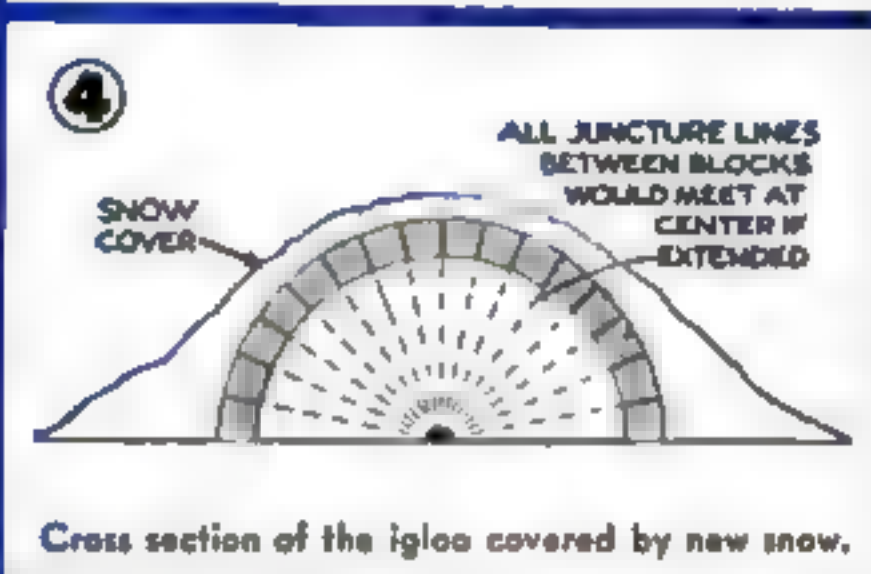
Cutting with a guide makes the blocks regular.



Reverse the guide each time to cut this pattern.



Lay the snow blocks with the slant at the top.



Cross section of the igloo covered by new snow.

plaster with new snow. Leaves, underbrush, boards, moss, and the like make a good insulated floor. Be careful of open fires on such material, especially if the igloo is used by children. Although kerosene lanterns

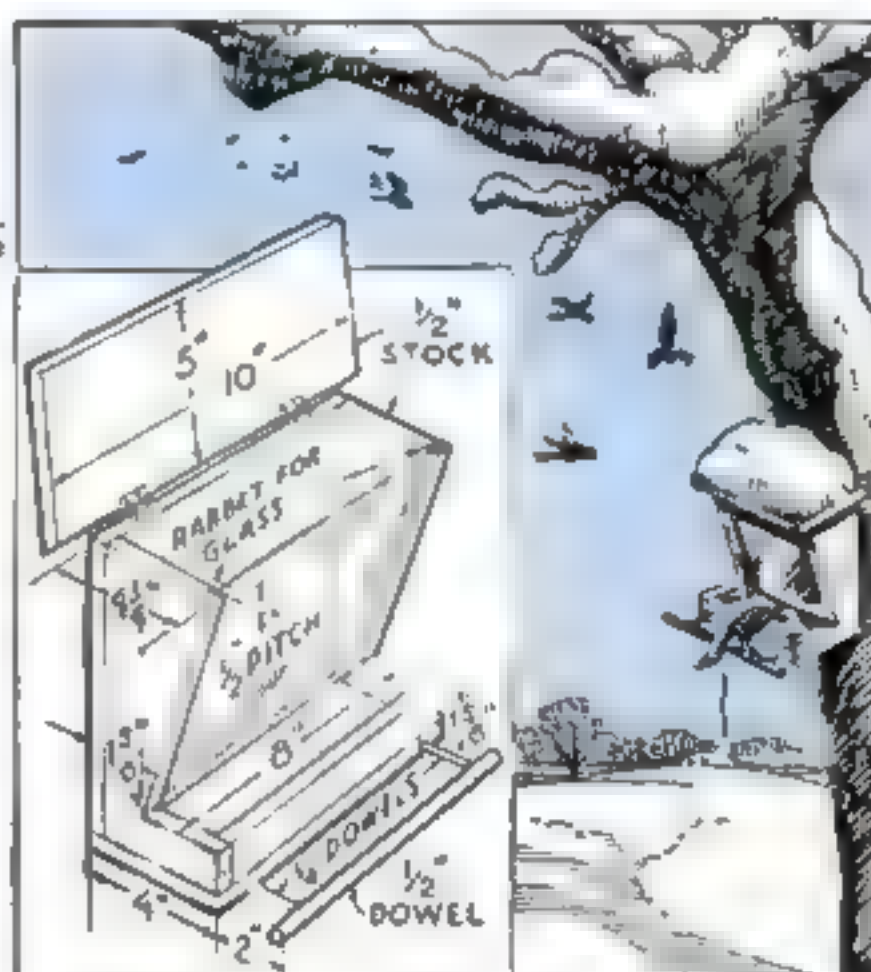
and candles can be used with care, bricks or rocks heated in an outside fire are safer. If an open fire is used inside, shield the dome above it to prevent weakening and possible collapse.—JACK T. HOLMES.

Automatic Bird Feeder Has Grain Bin That Shows Contents

MUCH pleasure can be derived from observing those birds that brave the snows to remain with us in winter. Here is an automatic feeder that will attract them to the trees in your yard by providing them with grain when other food is hard to find.

Make the feeder from $\frac{1}{2}$ " stock. If an 8" by 8 $\frac{1}{2}$ " board is not available for the back, this part can be made from two pieces edge-glued and reinforced with a cleat. Stop the rabbets for the glass front about 1" from the bottom of the sides to leave space for the grain to go through and keep the feed trough filled. You will be able to tell at a glance when more grain is needed in the bin. The top slopes toward the front and is wider and longer than the reservoir opening to protect the stored grain. A dowel bar provides a place for birds to stand while feeding.

Finish with three coats of boiled linseed oil and hang the feeder by screw eyes inserted in the back.—WILLIAM FREEMAN.



AX HANDLES



1 What do you do when an ax handle is damaged? The best thing is to get rid of it before it causes an accident. Saw it off close to the head, using a hacksaw in case you hit the metal wedges.



2 Then drive out the piece left with a punch and clean off rust with kerosene or rust remover. You will see that the eye is slightly spool-shaped, narrower at the middle than it is at the openings.



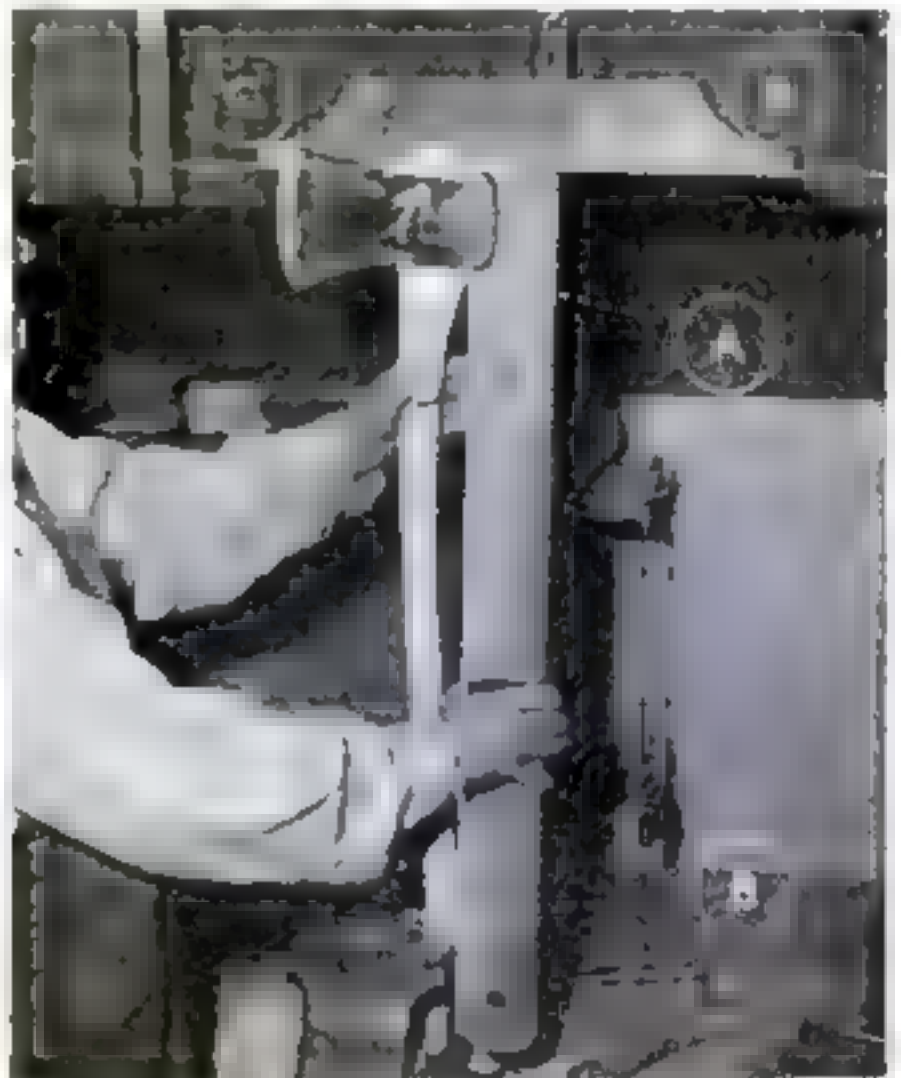
3 Most handles need trimming to fit the eye. A drawknife and rasp can be used. Take a little off at a time, trying the end frequently for fit.



4 When you start driving the handle in, the eye will cause thin shavings to rise. Remove with a rasp, keeping your fingers away from the blade.

5 Drive the handle little by little, fitting it into the eye as you go by taking off the high spots. To prevent splitting the grip, saw off a small section of the tip where the hammer strikes.

6 For correct balance, drive the handle in until only 1" of shoulder is left. It should be just loose enough to move. Line C-D on the head should be square with A-B, from shoulder to grip.



THAT STAY PUT

By RICHARD W. EMERY

Photos by RAY CHAPIN

You Need Only Simple Tools, Together With Some Care and Patience, to Bond Head and Shaft Securely for Service as a Balanced Unit

SOMEWHERE in the average garage or woodshed there is an ax with a loose head or a bashed and splintered handle. Kept in service in bad condition, it is more a potential danger than a useful tool. While the standard treatment for a loose ax head—soaking it for a time in a bucket of water—will help temporarily, it is not a permanent or even satisfactory repair.

And yet it is not much of a job to put in a new handle—and to put it in right so it will stay in. Ten fundamental and easy steps, from removing the old, wobbly handle to the final wedging and trimming of the new, are shown in the accompanying photos. None of them requires tools more uncommon than a hammer, a hacksaw, a draw-

knife, a rasp, or a chisel to do the job well.

The main thing to remember in fitting the handle is to trim the end only a little at a time, trying it in the eye frequently, so you won't get it too loose. Drive it in little by little also, trimming off the shavings that the eye raises as you go.

Once the handle has been driven in the proper distance, square it with the head to get correct balance and to make your swing easy and without effort. Then wedge the end carefully to expand it and fill entirely the space in the head. If this is done correctly, you need never fear losing the head in the middle of a swing, for when a new handle is put in an ax right and tight, it's there to stay put.



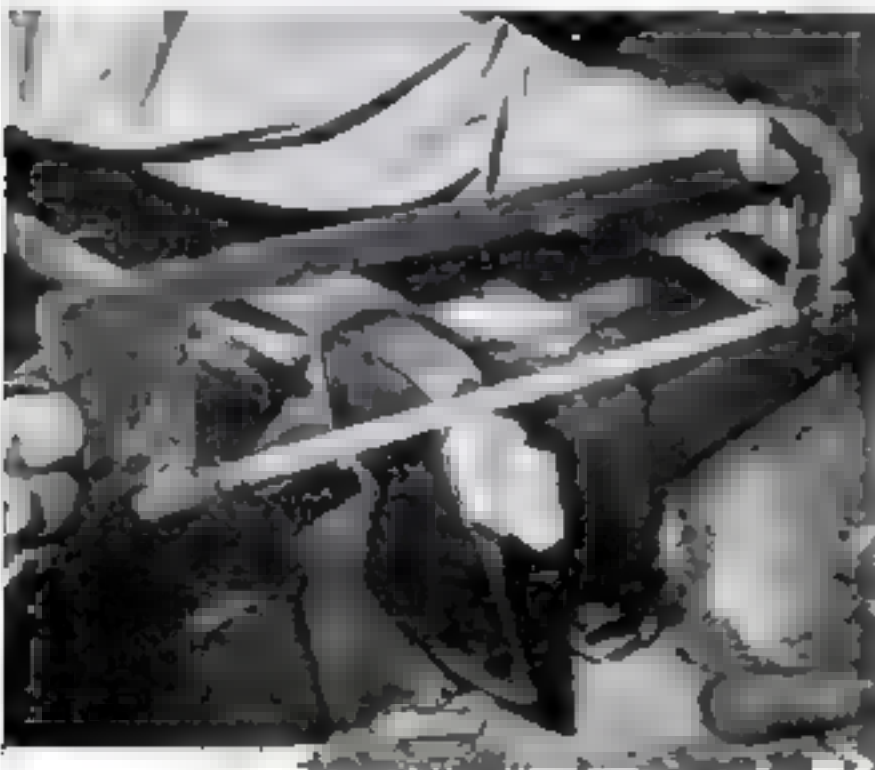
7 Keeping the head square with the handle, hold the head in the vise and split the end of the handle with a thin-bladed chisel to provide entrance for a wooden wedge that spreads the end.



8 Make a wedge of wood softer than the hickory of the handle and long enough to reach nearly halfway into the eye. Splitting doesn't spoil it. Drive all pieces in firmly as far as they will go.

9 Using a hacksaw, saw off the protruding end of the handle and wedge flush with the head. The wedge will have spread out the sides so they fit snugly, but the ends will show open spaces.

10 These end spaces are filled up by expanding the handle in that direction with two metal wedges driven in across the wooden one. If space still shows, plug it up with a small wooden wedge.



Smart Jewelry Created by Cementing Sea Shells

BEACHCOMBING, rarely a monotonous or unrewarding activity, can provide you with materials for wonderfully colorful ornaments, jewelry, and other trinkets. If you have neither shells nor easy access to a beach, look through the classified phone book of a large city under Notions or Novelties—you'll find there the addresses of firms that, for a dollar or so, will sell you enough shells and findings for many projects.

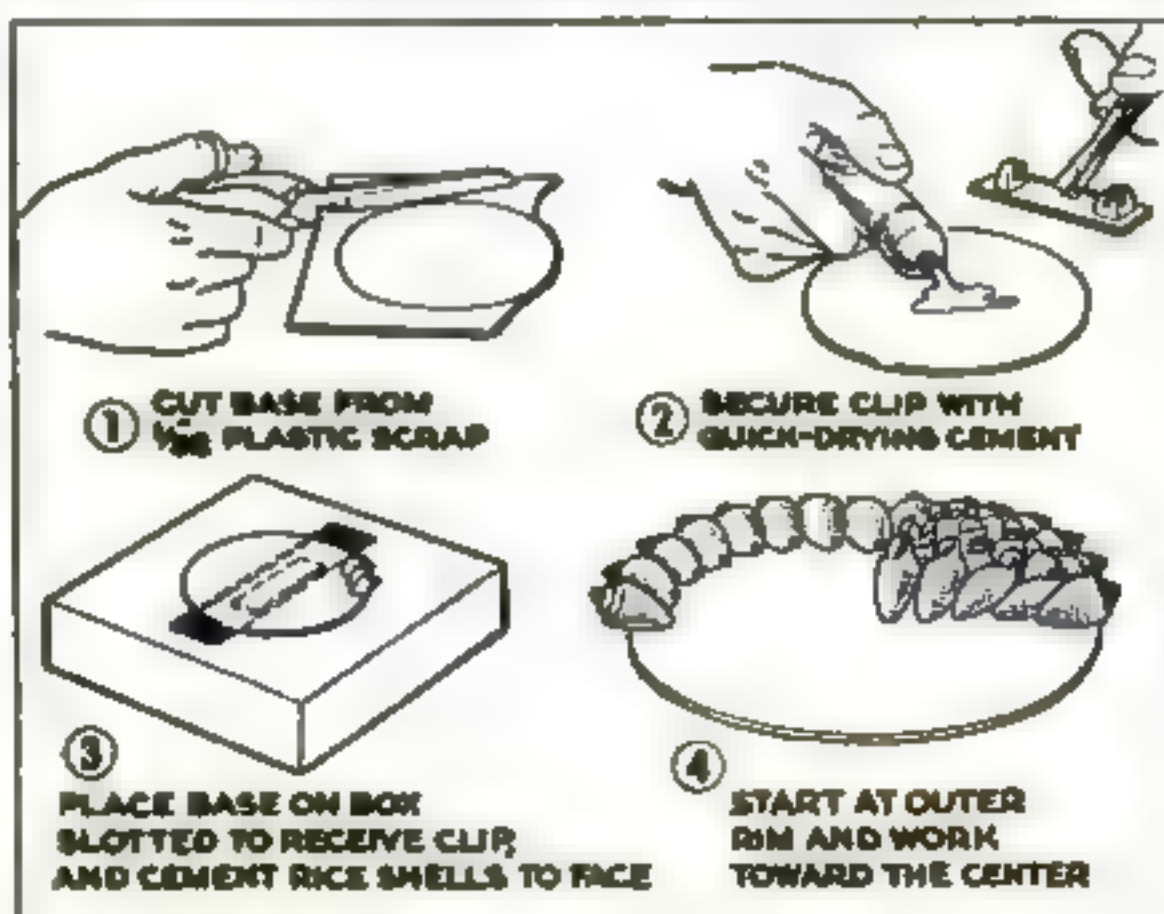
Get some $\frac{1}{4}$ " to 2" clear plastic disks, some plastic links $\frac{1}{4}$ " to $\frac{3}{4}$ " in diameter, and a dozen pin backs and earring clips. These, a handful of small, bright-colored shells and a tube of quick-drying cement are all you need. Start by making a pair of earrings, using tiny shells cemented to $\frac{1}{4}$ " plastic disks. A slotted box, as shown below, permits an earring or brooch to be conveniently built up after the clip is attached.

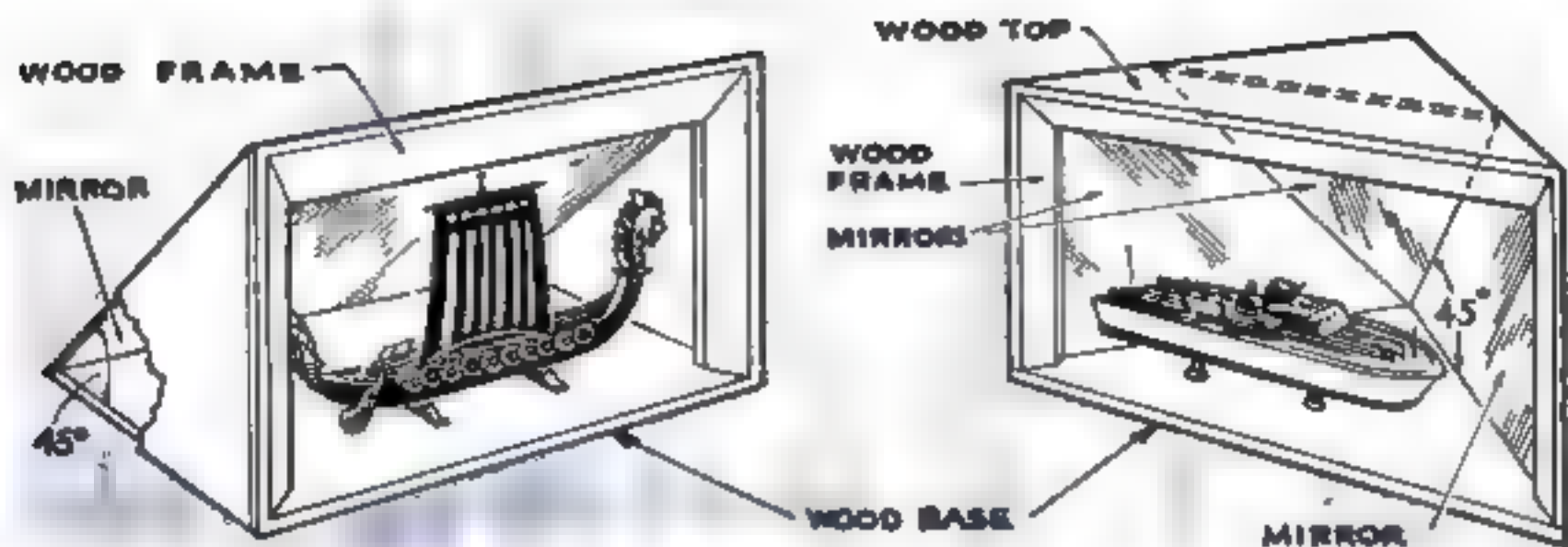
Once you've got the hang of it, let your imagination take the reins. An ashtray can be made by cementing a plastic link to the bottom of a good-sized shell, or by cementing two such shells back to back. Or a tiny flowerpot may be produced by attaching a colorful link to the base of a helmet shell. An ornamental comb is easy: cement a pattern of brightly colored shells to the side of the comb. A miniature tea set,

complete with teapot, cups, saucers, and tiny spoons, might be placed on a small mirror. Other possibilities include dolls and conch-shell boudoir lamps.—MARIA MORAVSKY.



Shells, pipe cleaners, and a painted-in face make this doll. Other shell creations are shown on page 120.





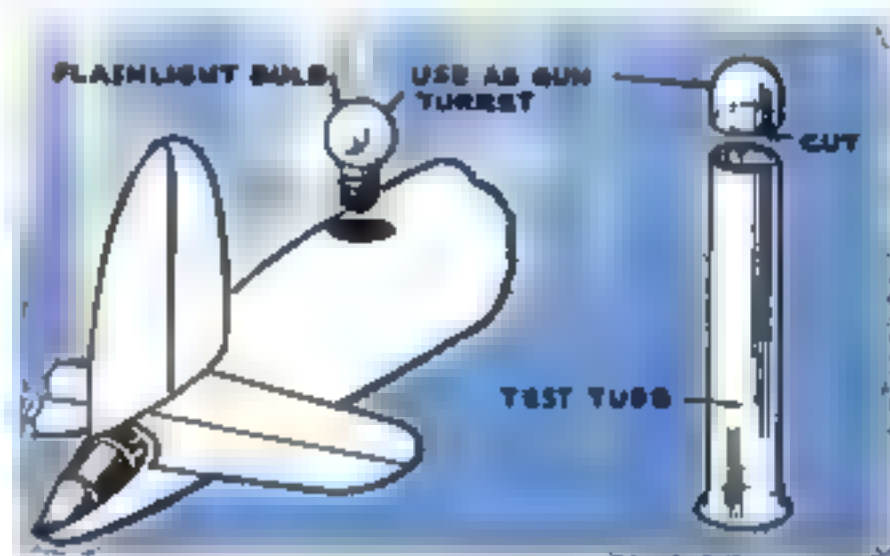
Mirrored Cases Reflect Top and Back of Models on Display

No "HANDS OFF" signs are necessary if you display your favorite models in cases fitted with mirrors that give an all-around view. For a mantel or the top of a bookcase, an effective case can be made with a 45-deg. back to which a single mirror is attached,

as shown at the left above, while a case shaped like that at right and containing three triangular mirrors fits nicely into a corner. The frame molding may be of any depth suited to the models that are to be shown in the case.—P. B. MORSLEY.

Ends of Test Tubes Serve as Model-Plane Turrets

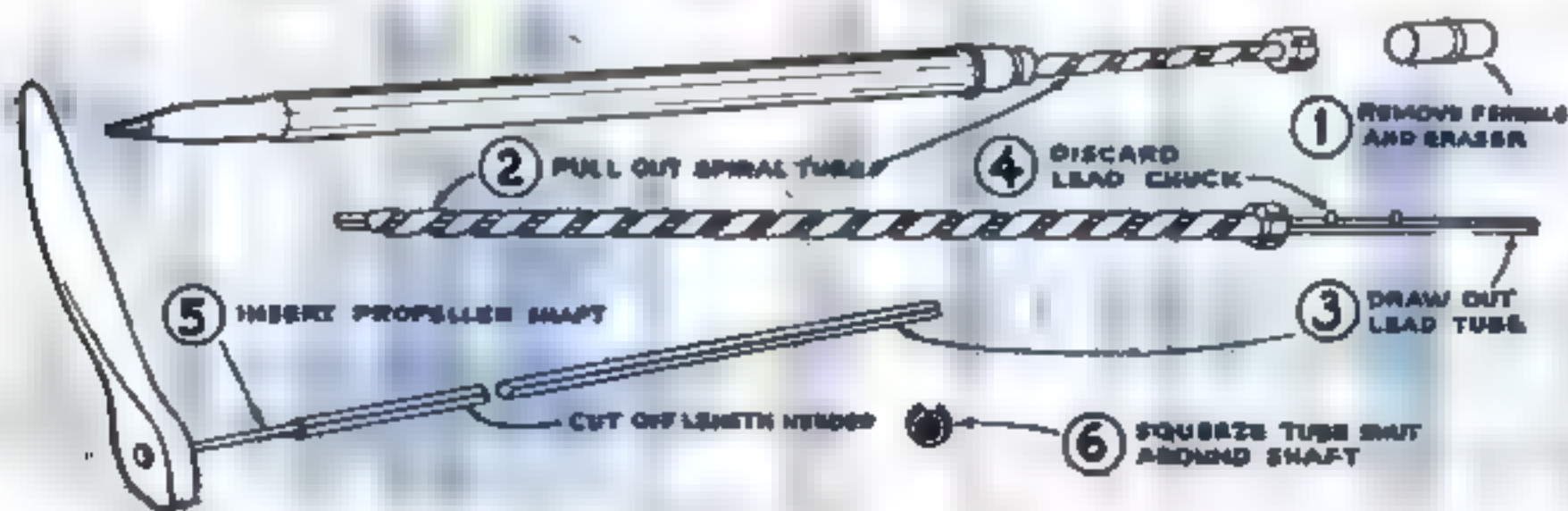
BLISTERS and gun turrets for model planes can be made by cutting off the ends of test tubes and fitting them into suitable holes in the fuselage. One method of cutting the glass is by filing part way through with a triangular file, wrapping with a string soaked in lighter fluid or gasoline, and igniting. Burned-out flashlight bulbs may also be used to make good turrets.—FREDDY MITCHELL.

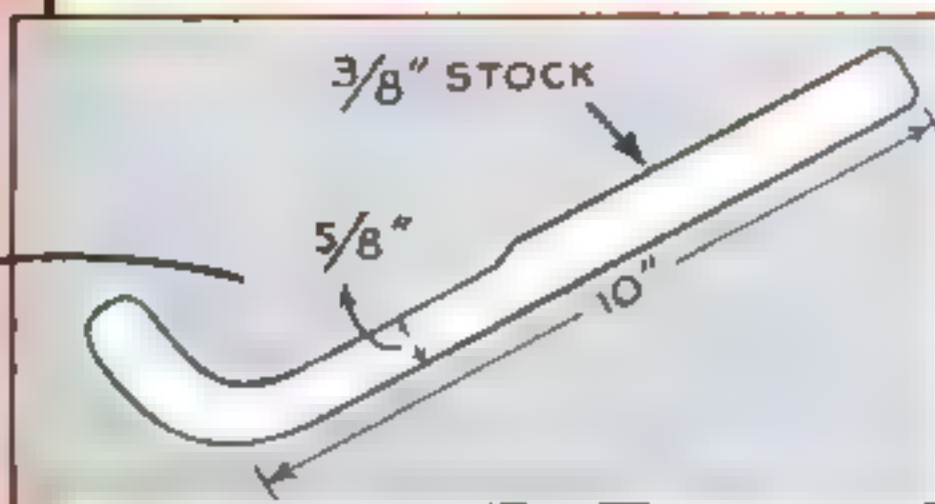
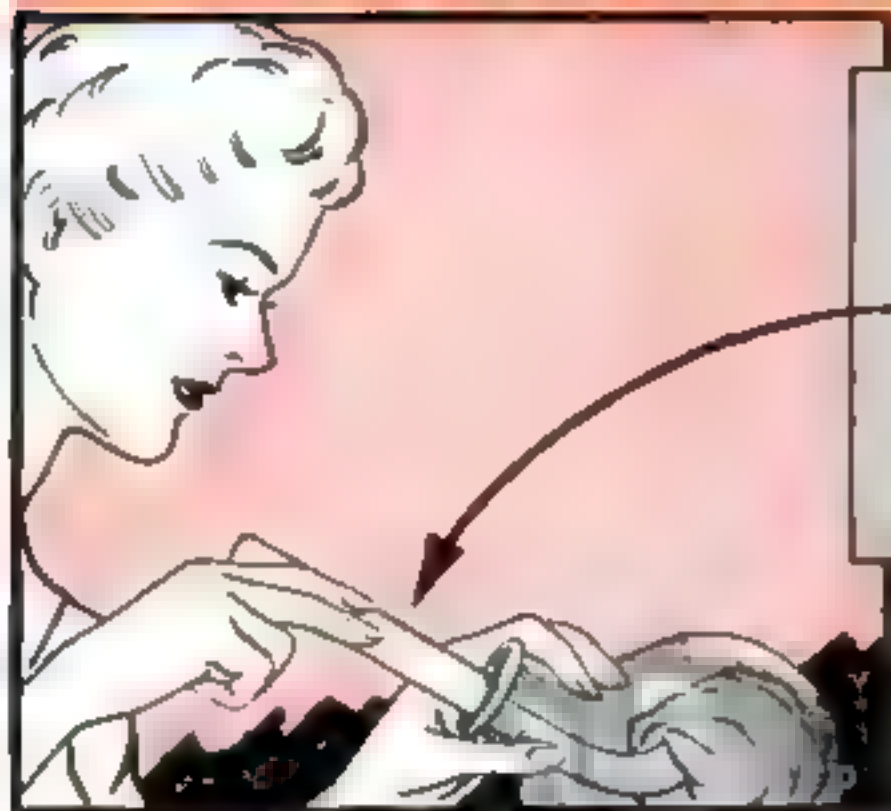


Lead Tube from Mechanical Pencil Forms Bearings for Plane

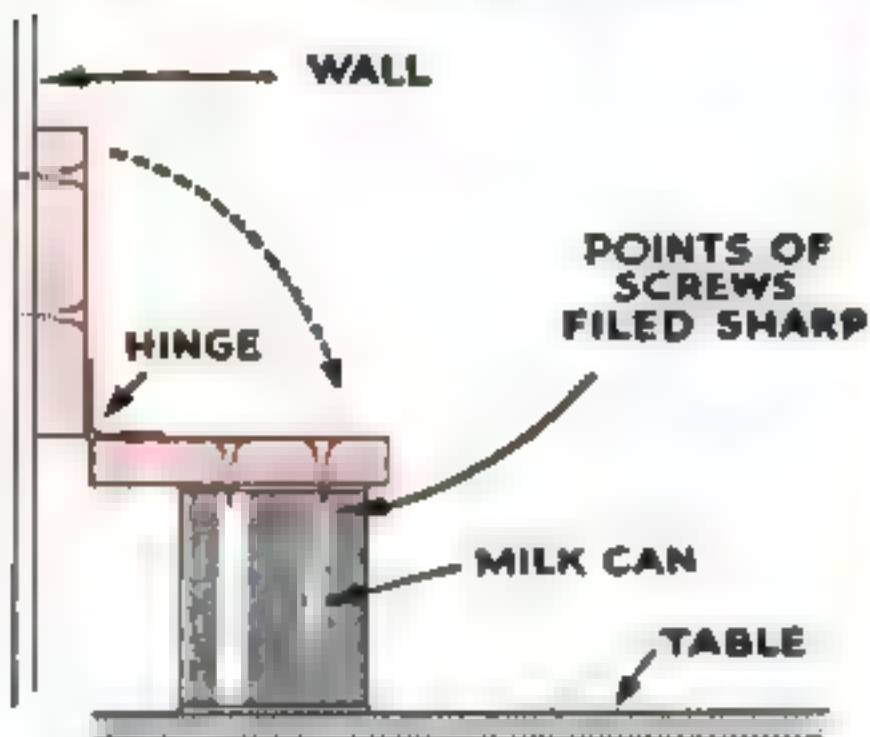
SEVERAL model propeller bearings, wheel bushings, hinge mounts, and the like can be cut from the lead tube taken from a cheap or damaged mechanical pencil. Disassemble the pencil as shown below and cut off the length of tubing needed. Squeeze the tube

around the shaft with pliers or in a vise until a close but free-running fit for the shaft is obtained. If the hole is still too big, cut through the slot with a hacksaw and again squeeze it shut. Standard and thin-lead pencils afford two tube sizes.—H. W.

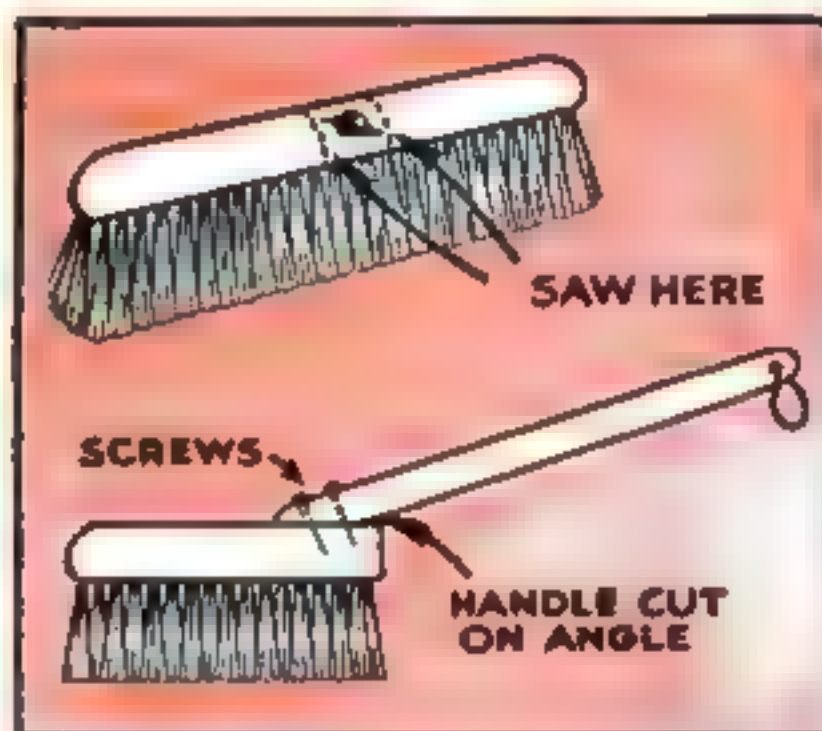




Scrubbing the inside of a glass coffee maker or a narrow-necked clear vase is sometimes difficult, but with a cleaning stick shaped like this you can reach all parts. Place a wash cloth over the neck of the container and push it in with the stick.



If you use evaporated milk in large quantities, a homemade can puncher will save time. Drill holes for the two punch screws well undersize and attach the hinged blocks to the wall at exact can height.

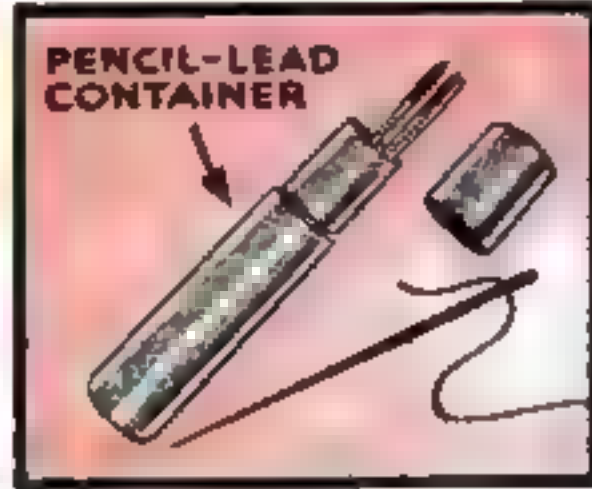


Two dust brushes can be made from a broken floor brush that has been discarded. Just saw on both sides of the break and add short handles. Part of the old handle or of an old broom can be used.

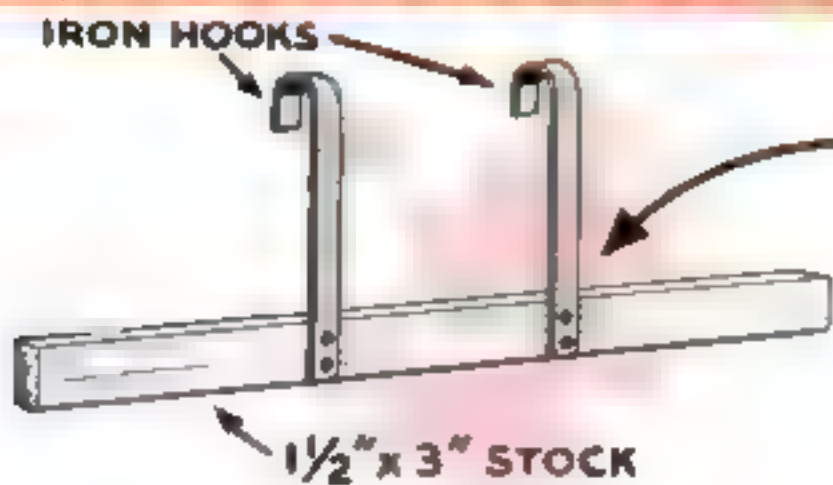
Use of a worn-out feeding nipple on a catchup bottle will give you an efficient clothes sprinkler for ironing day. Burn extra holes in the nipple with a heated needle.

Small, porous drawstring bags of the kind used to ship screws and samples make good containers for soap scraps. They wear well, and water and suds go through easily.

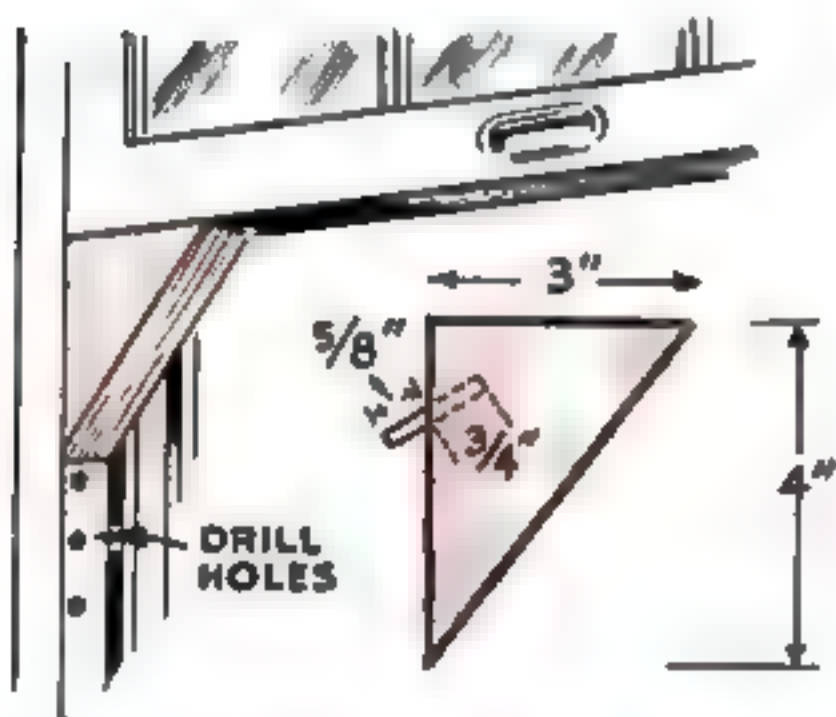
Wood and plastic boxes in which mechanical-pencil lead is sold hold needles safely in a sewing basket or provide a case for a packetbook hosiery-mending kit.



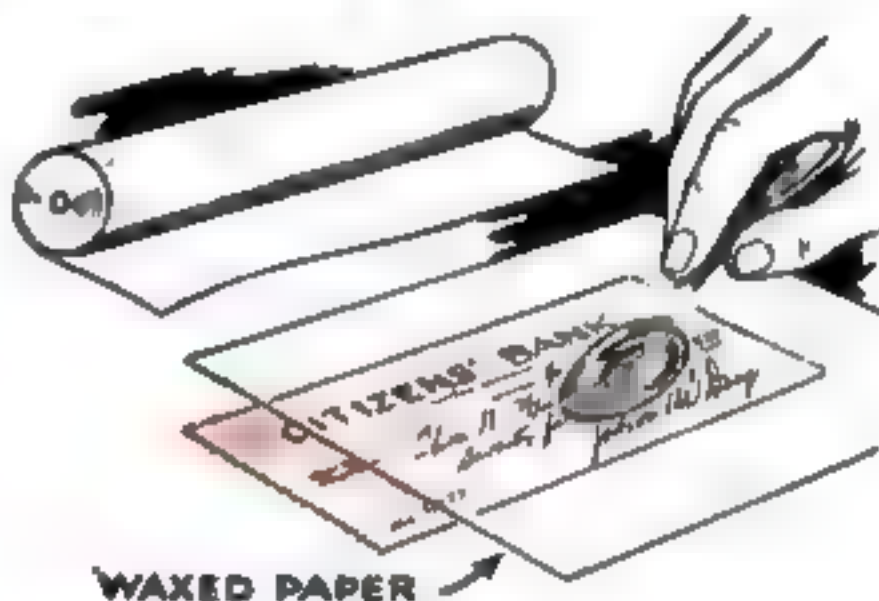
STIPS



When you are painting or repairing a window and can't reach the middle readily with the ladder on the sill, the top of the casing, or at one side, try supporting it with a bar hooked over the top rung. Have the bar wider than the window casing.



If it's inconvenient to replace a broken sash cord, a triangular block will hold the window open. Put a dowel or headless nail in the block at an angle. Drill several slanted holes in the track as above.

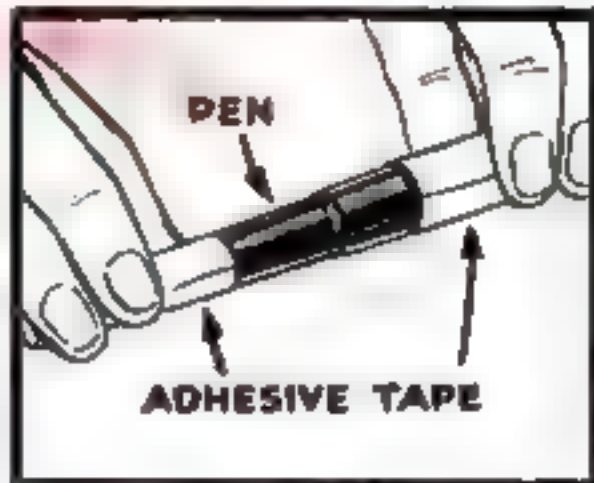
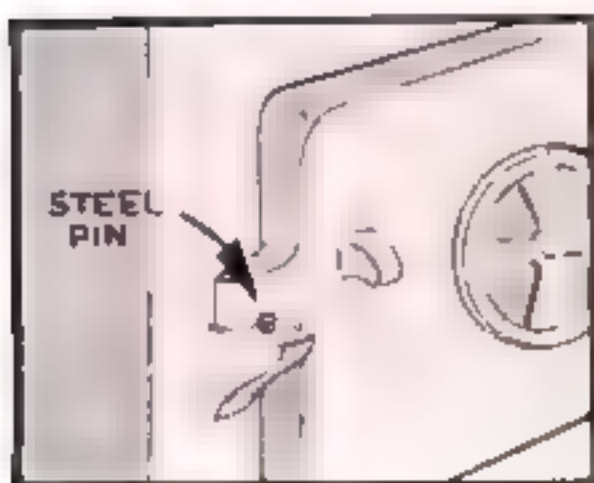


One way to protect household or personal checks from being raised without going to the expense of purchasing a check writer is to rub wax over the amount. Any tampering will then cause a smudge.

If a friction-type latch lets a furnace ash door slip ajar, control of the fire is lost. For positive locking, drill a hole in the latch lug and drive into it a steel pin.

Storage of twigs and other small pieces of wood used for kindling is neater if the wood is tied up in bundles. Make each fagot just the size needed to start one fire.

To unscrew a jammed fountain-pen cap, first wrap both the cap and barrel with a length of adhesive tape, covering up the surface to provide a finger grip.

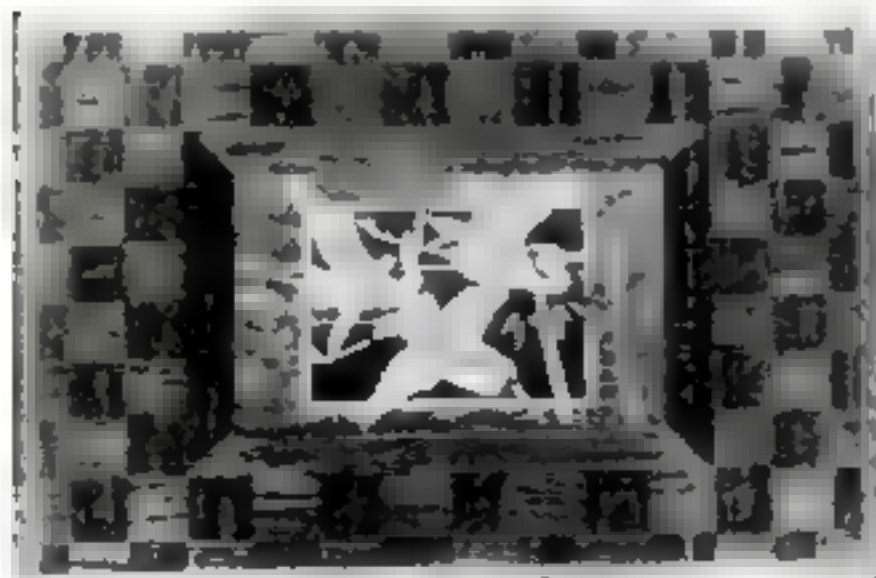


CRAFTSMEN AT WORK



WITCH DOCTOR'S THRONE? No, this horn rocker is the product of an American craftsman of two generations ago. Mrs. George W. Schulte, of Paducah, Ky., says it's still sound after 40 years of use. She got it from the first owner's granddaughter.

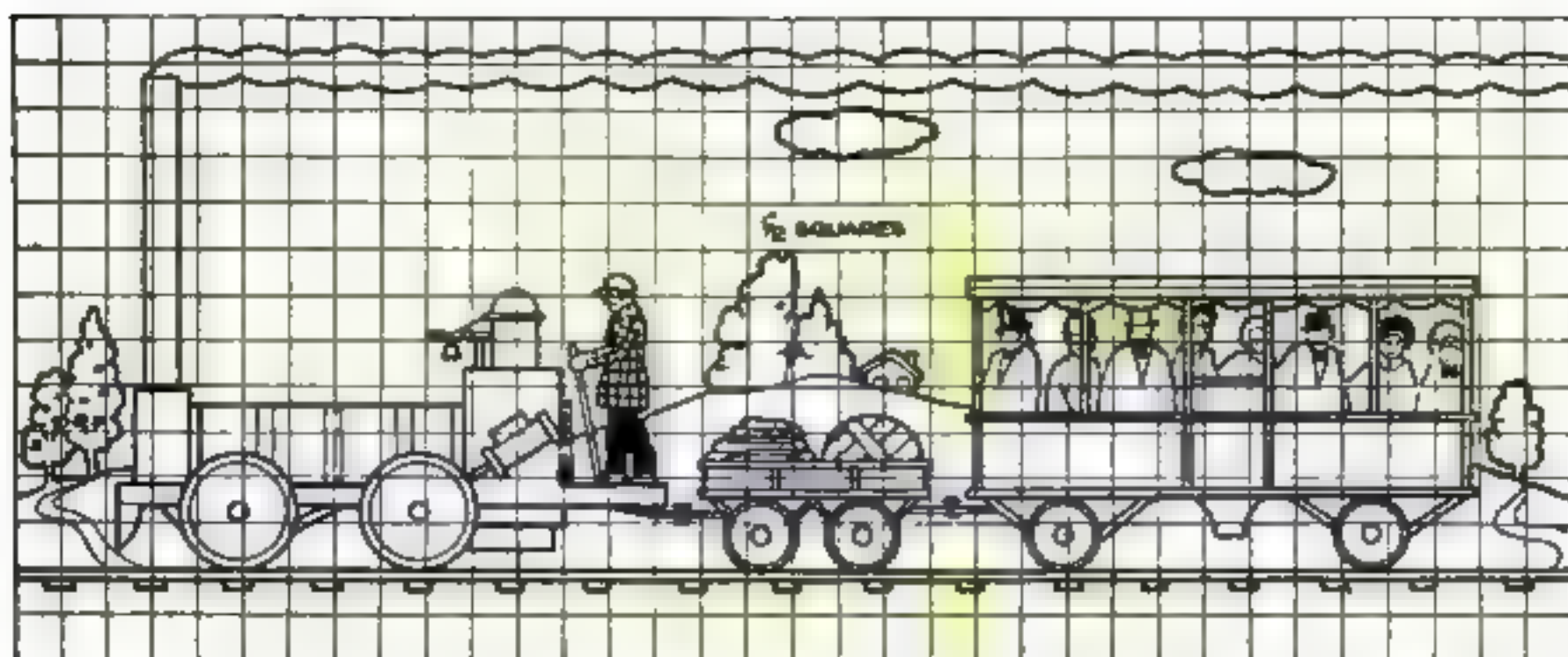
INTRICATE INLAY WORK doesn't scare Arthur E. Erickson, of Lewiston, Idaho, who designed and made the handsome serving tray shown below. He used a total of 451 pieces of 1/28" veneer in 10 beautiful woods, some rare and exotic. The 1" squares in a contrasting-grain checker pattern around the central panel are of bright-red East Indian vermillion, and the other woods are walnut, rosewood, satinwood, boxwood, holly, pear, ebony, amaranth, and gum.



RESTORING INDIAN VASES is a scientific jigsaw puzzle enjoyed by 17-year-old Robert Hall, of Green Bay, Wis. He restores ancient Indian pottery by a method he devised himself, using hot wax, bamboo splints, and cotton fibers to fit together hundreds of small pieces obtained by his own archaeological excavations in old caves. His work has won recognition at the Science Talent Institute in Washington, D. C., where he was a finalist in the competition for Westinghouse scholarships.

MODERN ANTIQUE. Craftsmanship of a high caliber is evidenced by a percussion pistol, vintage of 1838, made by Clifford E. Penniston, of Argyle, Wis. It's a real, full-size gun, built from plans of a half-size wood model in the January, 1942, issue of *POPULAR SCIENCE MONTHLY*. Penniston hasn't fired the pistol because of cracks in the metal stock of the barrel, which he plans to replace. He is a member of the National Muzzle-Loading Rifle Association.





Old-Time Engine Design Is Decorative Novelty

By NADINE WALTON

FROM Colonial days through the first part of our national life, our American forebears used color decorations extensively. We may be sure that the railroad motif was not neglected when the iron horse came into being. Here is an original design in the spirit of those times. The fireplace bucket to which it was applied is shown below and also in full color on page 120. Other projects for which the design might be suitable are a fire screen, a hooked rug, needlepoint work, or a painted tray.

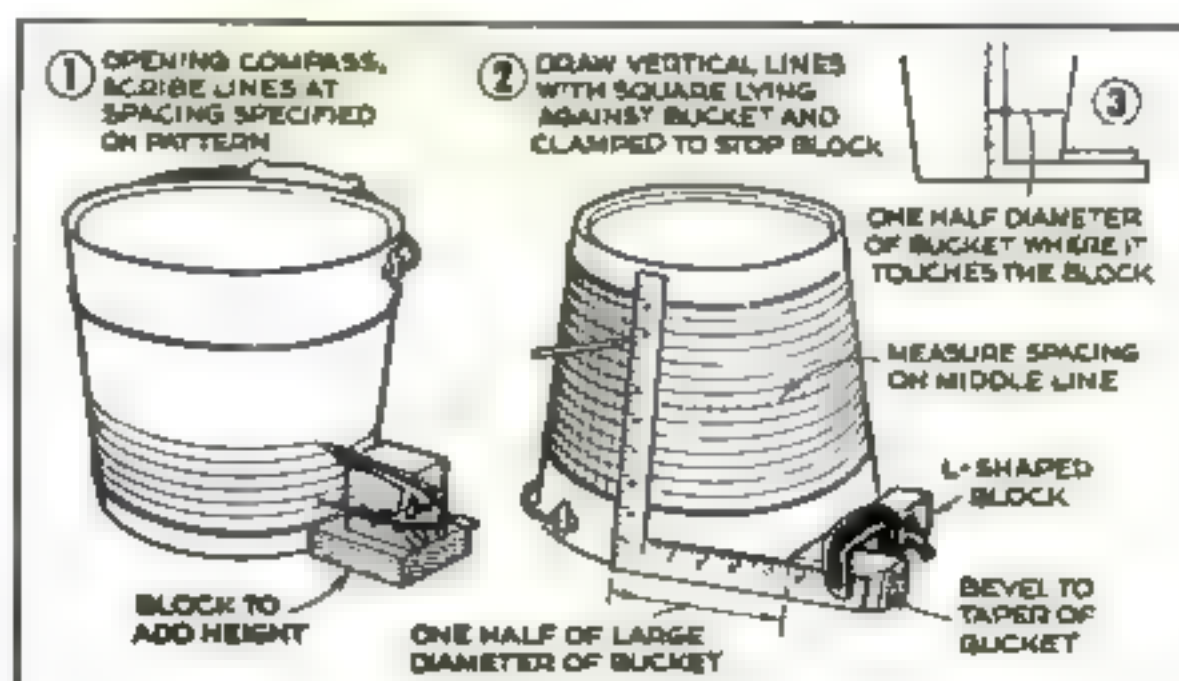
The bucket was purchased unfinished, painted black inside, and given a priming coat and an undercoat on the outside. Then the design was painted on with enamels. A coat of antiquing glaze was applied over all and rubbed into the crevices.

To transfer a pattern given on squares, lay out an accurate grid of squares on the work or on paper. These should be of a size that will afford the desired scale. The pattern is followed on the original squares and drawn in from point to point on the corre-

sponding squares. But on a conical surface like that of the bucket, vertical lines must conform to the taper. The squares will become trapezoids of differing sizes, but if the pattern is traced on them as though they were squares, the result will be satisfactory.

Place the bucket on a flat surface either on its bottom or upside down. Clamp a pencil compass to a block as shown in Fig. 1 and draw it around or turn the bucket to form a base line. Open the compass $\frac{1}{2}$ ", if $\frac{1}{2}$ " squares are wanted, and draw another line, repeating as necessary. When the compass cannot be opened further, put extra blocks under the first.

To make the verticals, mark off with dividers $\frac{1}{2}$ " intervals on a line midway between the top and bottom lines. Cut an L-shaped block with the short leg beveled at the same taper as the bucket, and clamp a steel square to it as in Fig. 2. Place the square against the bucket so that it touches all along the side; then draw the verticals at the points marked. If lugs or handles prevent placing the bucket upside down, use the setup shown in Fig. 3.



TRICKS

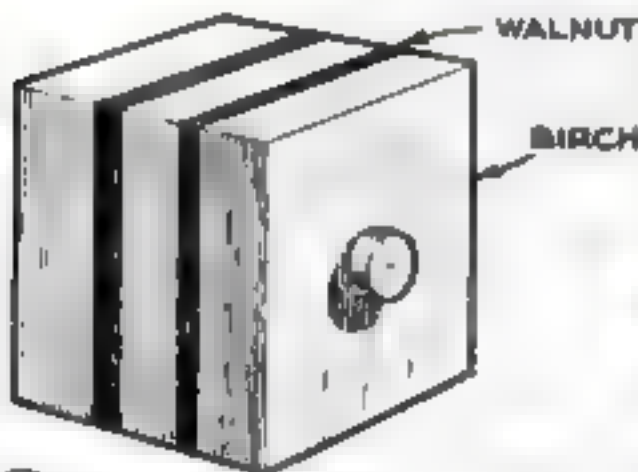
By EDWIN M. LOVE



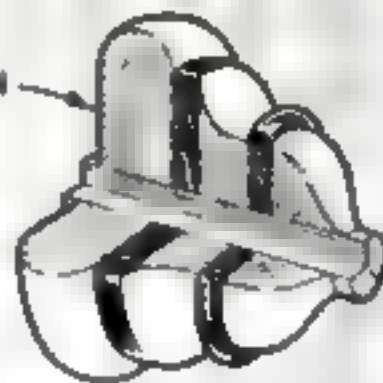
TURNING inlays is a fascinating branch of lathecraft. The intricate and striking patterns that characterize the work result from gluing together strips and blocks of variegated woods to form the turning squares. As the chisel shears through contrasting layers, accidental figures appear, and this element of chance adds to the interest.

More predictable designs in the form of bands of different colors are obtained by assembling wooden washers on a dowel or by gluing together concentric cylinders or

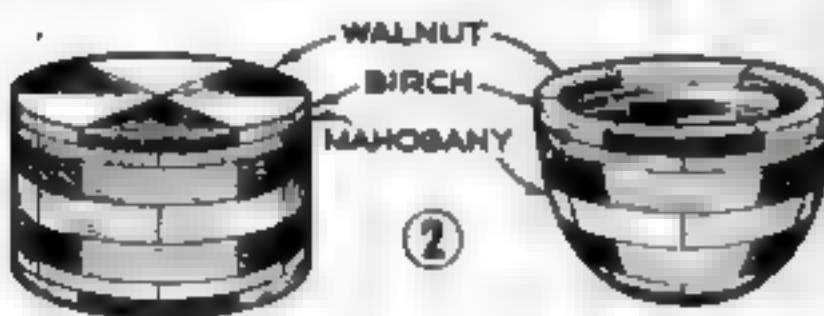
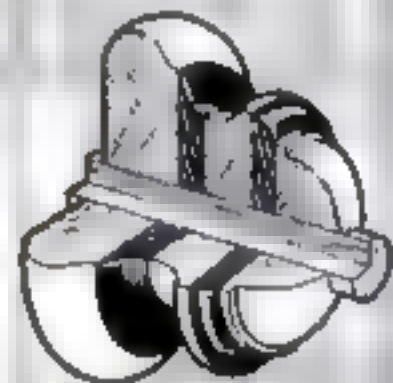
Four methods of gluing up turning blocks to control shapes of inlaid figures are shown below. Left, a turned inlaid lamp.



① DISK ASSEMBLY



ALTERNATE TURNINGS



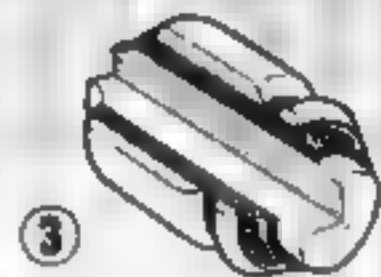
②

BOWL

SEGMENTED DISK ASSEMBLY FOR BOWL

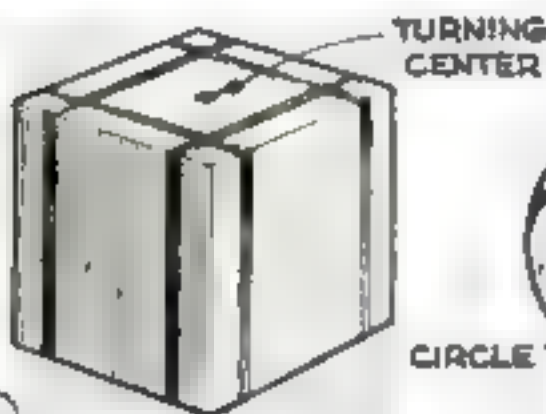


CONCENTRIC CYLINDER OR CONE ASSEMBLY



③

TURNING



④

GLUED-UP BLANK



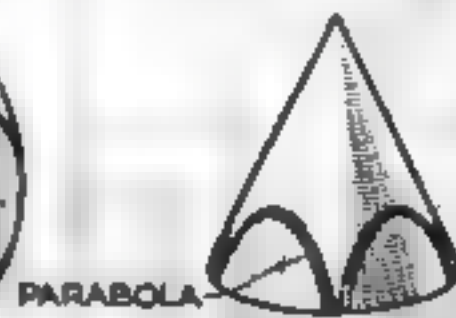
CIRCLE

TURNED AS SPHERE



OVAL

TURNED AS ELLIPSOID



PARABOLA

TURNED AS CONE

OF INLAY TURNING

cones. In this way some control over the design is possible, though accidental effects may occasionally appear. A rule or two will aid in planning. First, when a blank is glued up of pieces parallel to its turning axis, circular inlays can be expected on spherical turnings, elliptical on ovals, and parabolic on cones, as shown in the drawings on the facing page. Second, the width of the inlay depends on the angle at which the profile is cut.

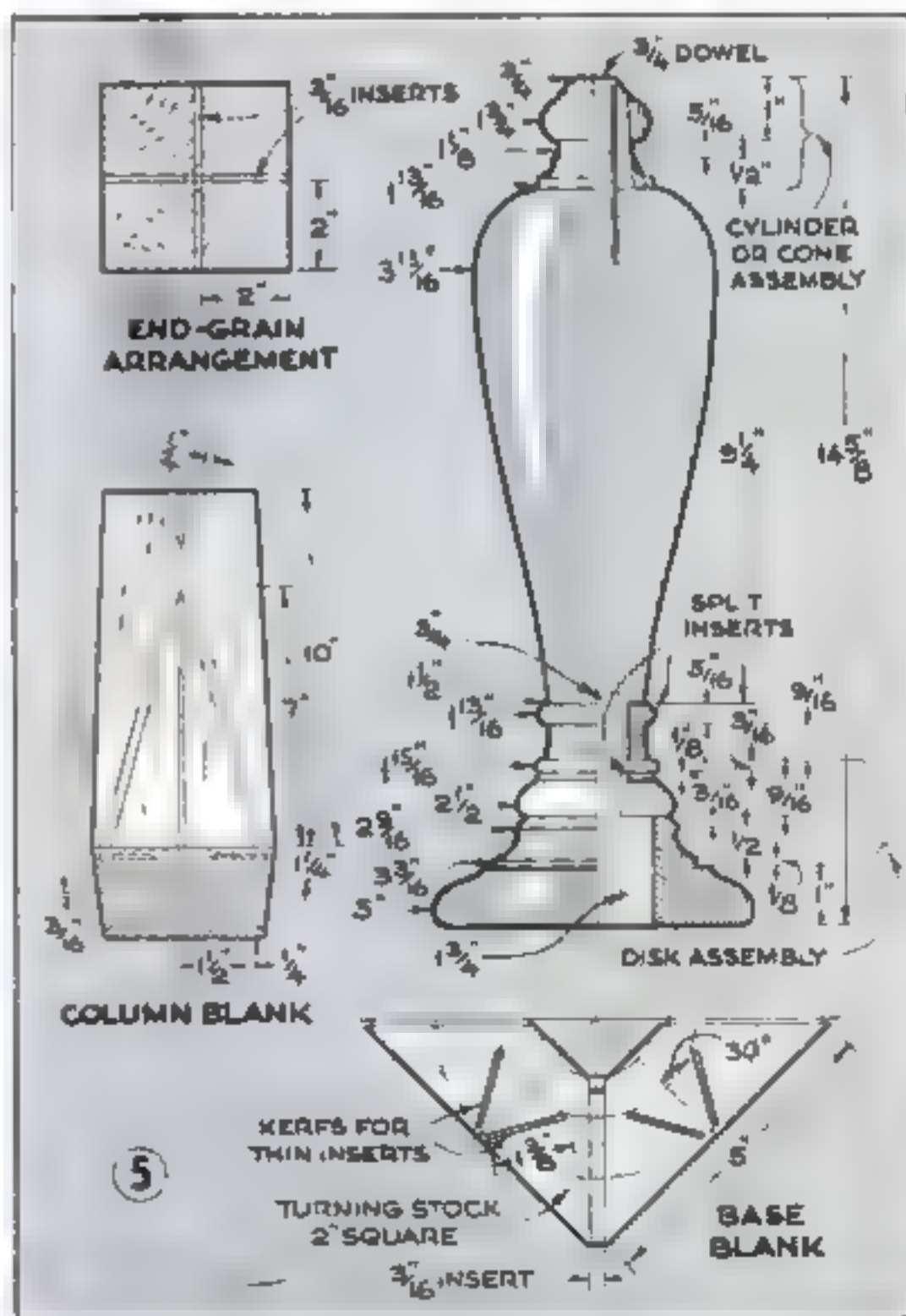
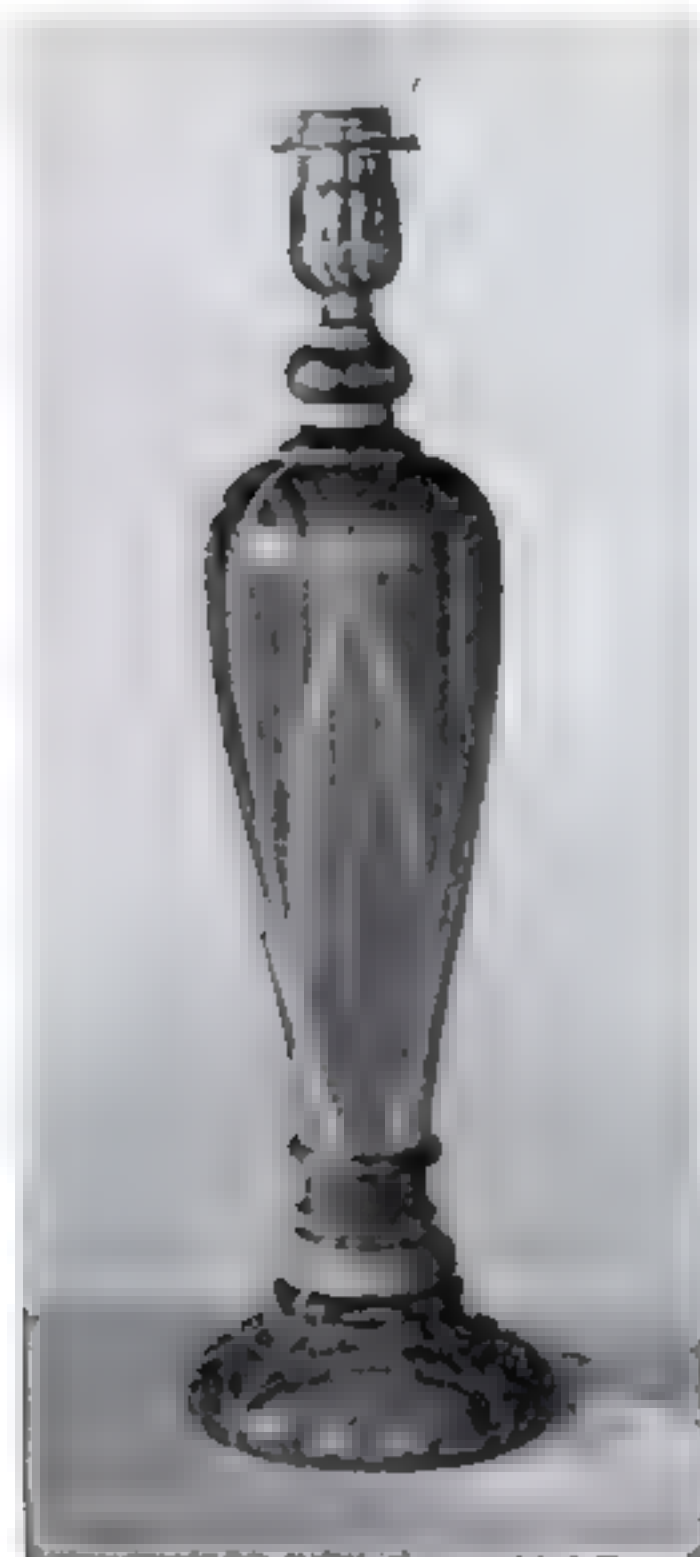
The accompanying photos and drawings illustrate the general method of gluing up turning squares. For the column assembly of the lamp shown, cut four pieces of 2" walnut turning square and arrange them with similar corners grouped at the center, forming symmetrical end-grain patterns.

How inlay appears on the lamp when the turning is completed. The standard is made in three pieces: a base, a central column, and a finial at the top.

Mark the two outer faces of each to identify them, and joint the inner faces. Glue the pieces in pairs with a strip of birch or maple in each joint, taking care to align the jointed faces accurately. Note that the inserts are flush with the outer faces but do not extend fully to the inner ones. When the glue has set, joint the halves and glue them together with strips of birch or maple between. To align the joints already glued, insert a short spline at each end of the grooves in the inner faces, as in one of the photos.

The process can be followed with a limitless number of combinations, each producing a different pattern with any given turning profile. And with any given glued-up combination, a different surface pattern

All dimensions for turning the standard are given below. At left is the glued-up turning square for the column; at bottom, half of the base assembly.





Turning squares are glued up with contrasting strips in the joints to make the lamp column. Note splines inserted to align the joints when glued pairs are finally joined.

In this setup, the glued-up turning square is grooved for crossing strips of inlay in a dado operation similar to taper ripping.



Parts for the base are glued with strips in the joints and banded for more inlays.

This disk on a fitted dowel is glued into the turned base to become a band. The cord hole can be bored in the lathe.

When the column and base are assembled, a groove is turned and the halves of a split insert glued in. They become a turned band.

Final turning is done on the top section, or finial, which is made up of hollow cylinders fitted together. Note the contrasting color as the cut goes through the outer layer.



appears every time the profile is modified.

For good results, corresponding strips of wood must be made accurately to dimensions, and glue joints must be strong to look well and to give the necessary solidity for turning. Equally important is accurate centering of both ends, as the slightest irregularity shows on the finished work.

Variety is added to the lamp column illustrated by strips of birch in deep grooves cut on the diagonal with a dado head. This operation is similar to ripping tapers. The work is held at the proper angle by a notched block slid along the fence. With some dado heads it may be necessary to make a special wooden insert that will permit the blade to be raised higher than normal.

Take one cut on each face, glue in the strips, and dress the projecting edges flush with the work. Then reset the fence on the other side of the dado head, turn the notched block over, and cut the other groove. Set the strips into these cuts, joint off the corners, and turn.

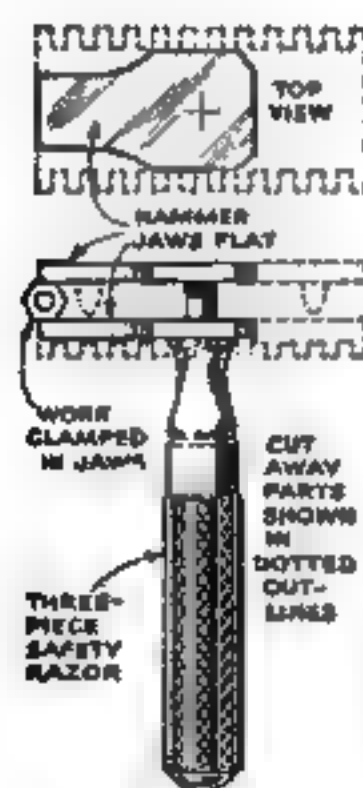
Gluing blocks end to end to carry the grain around the work is a method of assembly for round picture frames, bowls, and the like. It is illustrated in the lamp base. In this turning, four pieces of 2" turning square were cut with mitered ends and grouped for symmetrical arrangement of grain. After careful fitting of the miters, they were sized with thin glue, which was allowed to dry a little, and they were then assembled with strips of birch in the joints. When dry the bottom was surfaced and the face made parallel so either side could be placed against the miter-gauge head and saw kerfs cut for the thin inlays. With both faces trued, the table need be tilted only once to cut the angled kerfs. To facilitate

turning, saw off the corners from the block.

A disk-inlay assembly is built up on a turned core or dowel with disks of the desired thickness bored and glued together. If the assembly is part of a larger turning, it can be turned and glued on afterward. Or, as with the lamp standard, the dowel may be sized, glued into the base on the faceplate, and the piece then turned. The disks can be cut with the grain running through the turning or parallel to the axis. Still another method is to turn a groove in the work, make a disk or blank to fit, halve it with a chisel, glue it into the groove, and clamp. The split joints are invisible after turning, and the inlay can be made into a bead, stripe, or part of a curved profile.

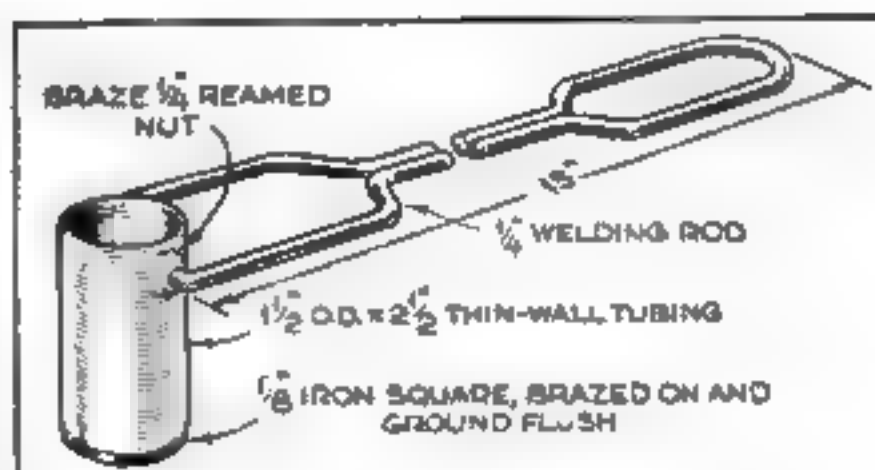
Cylindrical assembly is illustrated in the lamp finial. A core is first turned, and then hollow blocks of contrasting color are turned to fit and glued in place. If the layers are turned as cones, slight oversize boring can be taken up by sliding the parts until they wedge. It is often best to make a shoulder or other break at the juncture of contrasting colors because the borings may be slightly irregular and the banding divisions may not be clean as the tool cuts through one layer into the next.

If an inlay turning is to be stained, woods that are not to receive the stain should be covered with white shellac, a process that calls for careful work with a small brush. On woods contrasting naturally, a thinned coat of varnish may be sufficient. After the varnish had dried, the walnut of the lamp standard was treated with dark-oak filler, which was carefully rubbed off, and then sanded when dry with 6-0 garnet paper to remove all traces of filler from the light wood. A final coat of varnish was rubbed with pumice and water to a satin finish.



HAND VISE MADE FROM RAZOR

SAFETY razors of the three-piece type can be made to serve as handy clamps or hand vises for small, light work. The razor could be used without any modification other than removal of the two prongs of the upper jaw, but a more convenient tool will result if the parts are cut away as shown and the jaws hammered flat. R. C. ROETGER.



HANDY SOLDER LADLE MADE OF THIN-WALL TUBING

SAW tubing to size, and then braze on and grind the bottom. Bend the handle with the aid of a torch, leaving clearance for the pot to swing completely around between the handle prongs.—W. A. GRECUA.



Six .50-cal. machine guns are underneath the nose to keep gun flash from affecting the pilot's vision.

Shooting Star—Speed King of the Air

By PAUL PLECAN

ONE of Uncle Sam's latest warbirds, the Lockheed P-80 Shooting Star is also one of the fastest. With glass-smooth "piano" finish, clean aerodynamic lines, and a powerful jet engine, it will do at least 550 miles an hour—its top speed hasn't been announced. The plane was designed to operate at altitudes above 45,000' and, with dropable fuel tanks, to accompany long-range bombers. Its graceful lines make it an excellent project for the modelmaker.

The plans shown on the facing page will have to be enlarged, since they are half size. This can be most conveniently done by having a photostat made. The next best method is to complete the squares on the drawing, draw accurate $\frac{1}{2}$ " squares on another sheet, and then transfer the designs to that sheet for use as a pattern from which to work.

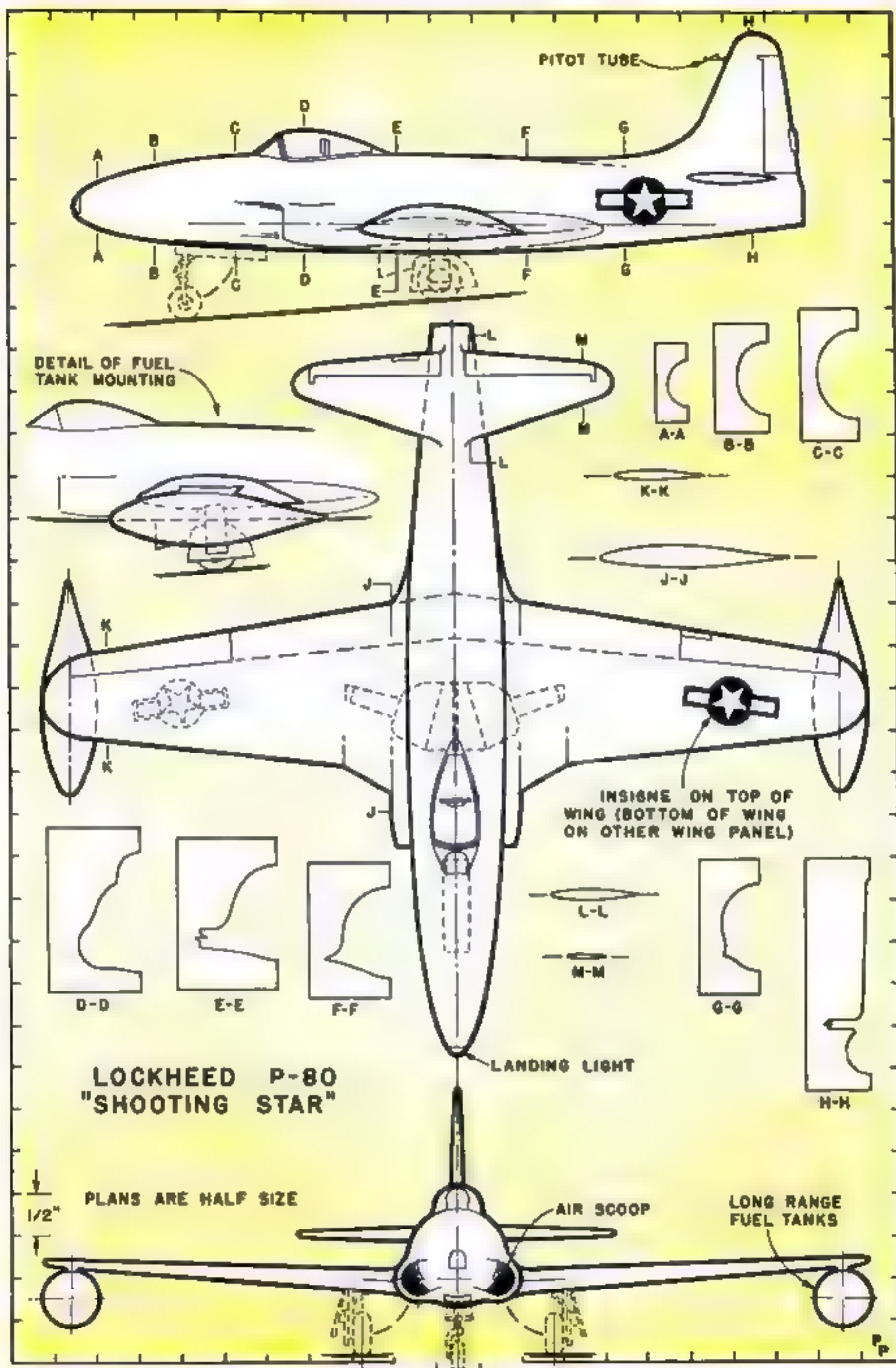
Time will be saved and the work made easier if the fuselage and air scoops are carved separately and joined on assembly. A slot should be cut through the fuselage to take the one-piece wing. The tail surfaces can next be shaped and mounted in place. Then, after the wing and tail have been checked for alignment, the extra details, such as the long-range fuel tanks and landing gear, can be added.

The entire model should be coated with

wood filler after assembly to hide the pores of the wood. Several coats of gray dope are next applied, sandpaper being used between coats to produce a satin-smooth finish. Then the insignia may be put on. Decals are available in most hobby stores and offer the easiest way. Finally, to obtain a glossy finish comparable to the prototype, apply a good grade of automobile polish.

Dropable fuel tanks are under the wing tips, a placement that reduces tank drag 40 to 50 percent.





SERVICEMEN AND VETERANS SEEK CRAFTWORK PRIZES

FOR THE best examples of craftwork by members of the armed forces, POPULAR SCIENCE MONTHLY is offering \$3,300 in prizes. So, if you are or have been a serviceman, why not submit that prized gadget you made? You lose nothing—and you may win \$1,000. But first, please read the contest rules carefully. They were printed on pages 150-151 of our December issue and can still be obtained by writing to POPULAR SCIENCE MONTHLY, 353 Fourth Avenue, New York 10, N. Y. The photos below show typical projects produced by servicemen.

\$3,300 IN PRIZES

First	\$1,000.
Second	500.
Third	200.
Fourth	125.
Fifth	100.
Sixth	75.
Seventh	50.

And 50 other awards of \$25 each.

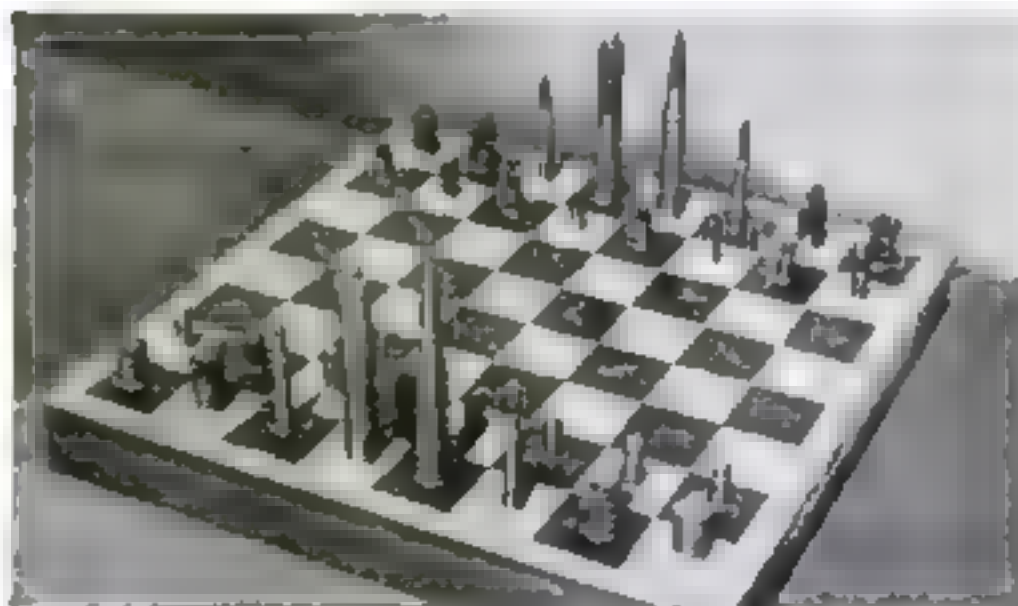


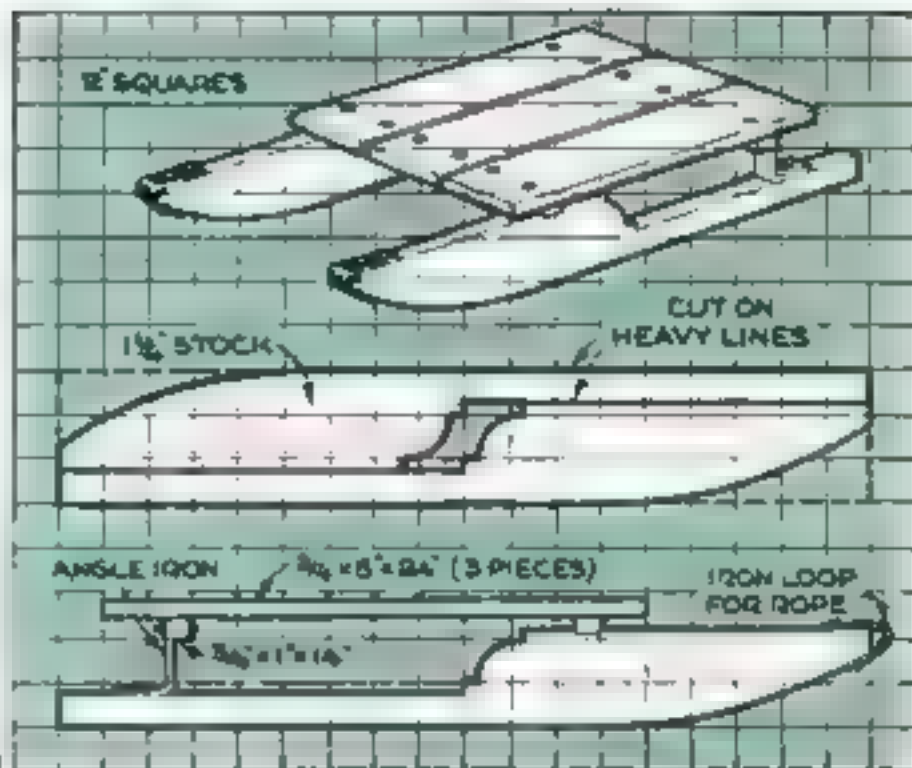
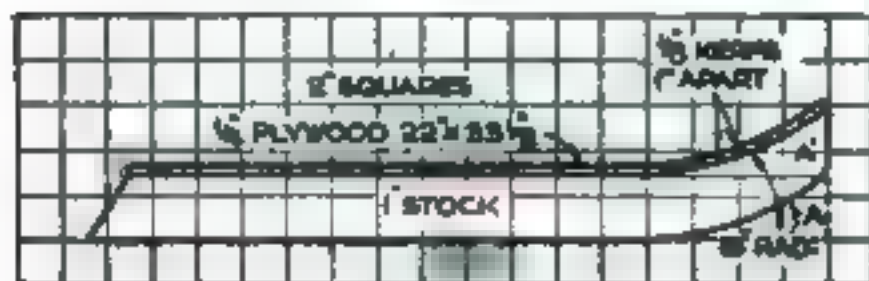
Herman Mintz of the Coast Guard served on one LST for 15 months. So it seems natural that he should have built this scale model of an LST. Asked what tools he used, he pulled out a razor blade, a carving knife, sandpaper, and a small drill. "That's the whole workshop," he grinned.



Sgt. John Cwikun made the table at left while convalescing at Halloran Hospital. Each turned upright was cut in three parts. The circular top and shelf were formed from plastic.

Roy Duckworth and Winston Bullard produced this chess set. All pieces and pawns are shells except the queens, which are Protex plugs used in aircraft engines during shipment.





Homemade Sleds for Young Children Are One-Evening Projects

TWO sturdy sleds, designed for pulling by hand, are shown in the drawings. Either will carry a small child with little danger of tipping, and may also be useful for hauling groceries or firewood. A clothesbasket screwed to the deck will hold a baby safely, or a low seat with sides may be installed.

Resin-bonded plywood forms the deck of the sled at left, which was designed by G. T. Marria, of Brantford, Ont. It is curved by cutting kerfs in the front, brushing waterproof resin glue into them, and gluing and nailing to the runners. Triangular longitudinal cleats strengthen the joint between

runners and deck. These runners are cut from 1" by 3" stock with the waste, shown at A, glued and toenailed on as A'. Drilled and countersunk steel strips 36" long are held to the bottom of the runners with flat-head screws.

Runners for the other sled, designed by T. MacDonald, of Thornhill, Ont., are cut from 1 1/4" by 3" stock, as shown. Two angle irons hold the back crosspiece to them, and the deck is screwed on. For easy pulling, runners should be 1/2" to 3/4" further apart at the back instead of parallel.

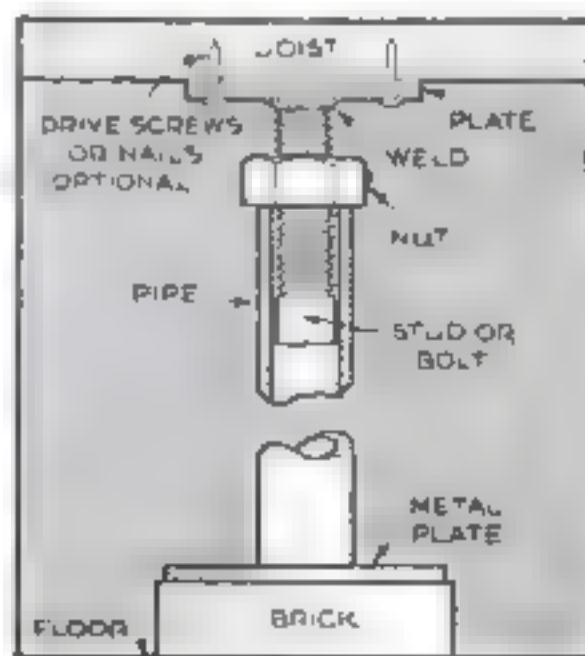
Finish with varnish and ski wax.

Adjustable Support Will Jack Sagging Joist Back into Position

Badly sagging floor joists may be returned to level with an adjustable support that is left permanently in place. The support is assembled from a 3/4" or larger bolt or threaded stud several inches long, a nut, a piece of steel 3/4" or more thick and at least 2" square, and a length of pipe or steel tubing large enough to receive the bolt.

Weld the steel plate to the threaded end

of the bolt after the nut has been put on; then slip the other end (with the bolt head cut down if necessary) into the pipe. The latter should be just long enough to permit a brick or a concrete block to be put under it. Turn the nut to jack up the joist. To prevent damage to plaster, doors, or windows, jack the joist up gradually over a period of days or even weeks.—W. E. B.



FLYING CRATE . . . Air



Giant cargo planes resembling this experimental model some day may transport freight rapidly and cheaply.

AIR lines engaged in freight operations may rely on the conventional types of large aircraft for several years, but it seems probable that, as competition grows keener, the need for a more efficient cargo plane will become apparent. Four-engine planes now in use are sleek and impressive, but their cost of operation is high.

With a design dictated by utility, and having as its aim the consistent and inexpensive delivery of goods, the freight plane of the future undoubtedly will be a rugged work horse, not a graceful sky hurtler. Speed need not be tremendous, for a rate twice that of the fastest ground travel should be sufficient for a long time.

This plane must be capable, however, of working out of small fields. It must have doors large enough to accommodate anything which will fit into the cargo compartment. The design should be such that loading additional cargo will not necessitate rearrangement of the remainder in order to provide an even weight distribution and good flight trim. The latter feature would

reduce "station-stop" time to a minimum.

Just such a design is represented by the model presented here. This little job can lift truly surprising weights into the air R.O.G. (rising off the ground), and loading may be made at any point in the cargo compartment with equally good results. The middle wing slides fore or aft to trim ship. In a full-sized ship, the sliding wing could be actuated hydraulically by the pilot with the aid of instruments showing the weight distribution in the cargo compartment. Thus he could land a plane with a load of feather dusters up forward, toss a grand piano into the rear, read his dials, and set the wing for perfect flight trim while he was taxiing out for the take-off.

Standard controls, ailerons on the front wings and rudders and elevators on the rear, would be used. Twin engines, mounted in the nose and tail, would provide plenty of power for the take-off. Once cruising altitude was reached the rear engine could be stopped, the propeller feathered, and the flight carried out with great fuel economy.

Freighter of the Future?

By ROY L. CLOUGH, JR.

In the model, two propellers rotating in opposite directions provide a powerful torque-free thrust, permitting the use of far less dihedral and giving greatly increased lifting ability for the wing area.

Construction is simple and conventional. For the fuselage use $\frac{1}{4}$ " square medium balsa strip. It may be necessary to soak the lower longerons in hot water for several minutes to get the proper curve near the nose. Gusset plates permit the omission of diagonals, so be sure to put them in. The forward part of the nose section is covered with $\frac{1}{16}$ " sheet, as shown on the plan. A cargo door is placed on the right side only. Notice that this opens downward, providing a ramp for easy loading of cargo.

After the fuselage has been covered in the customary manner, rails are installed atop each upper edge for adjustment of the middle wing back and forth. Make each rail of two pieces of hard balsa, one $\frac{3}{32}$ " square and another $\frac{3}{32}$ " by $\frac{1}{4}$ ", gluing the square member atop the fuselage and the second on this so as to provide an inner overhang.

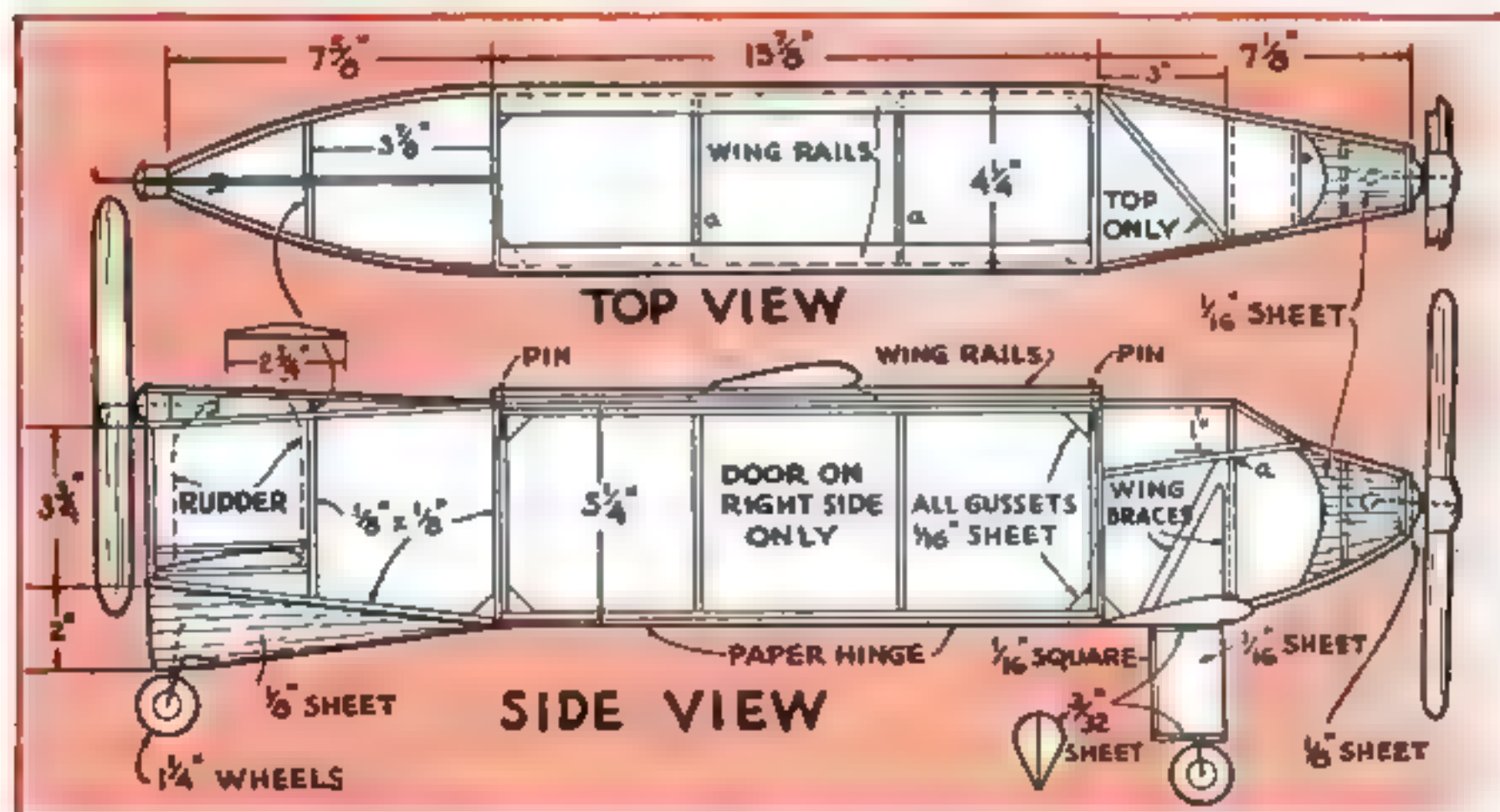


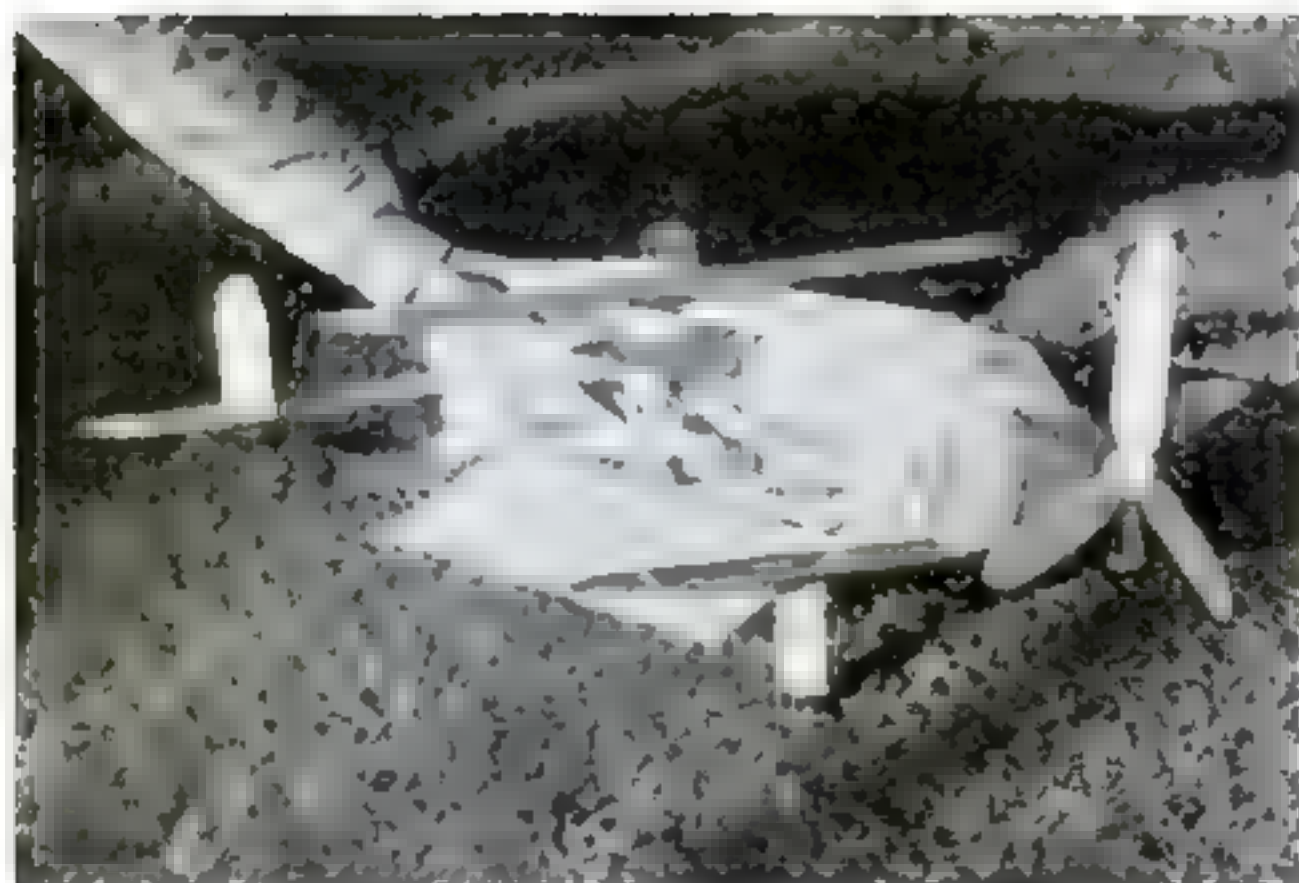
Adjustable fore and aft, the middle wing compensates for weight distribution of the cargo and keeps the plane in good flying trim.

How runners, also made of $\frac{3}{32}$ " hard balsa, are cemented to the wing is shown in the plan on page 172. There should be enough friction between the rails and the runners to hold the wing in any position it is set without the use of rubber bands.

One basic plan covers all three wings, but there are some slight variations in each. Although 38 ribs were used in the wings of the model shown in the photographs, it

Conventional methods are followed in building the model. Note that pins hold the door shut during flight.





Fully wound, the freighter will take aloft a cargo of light plastic toys.

is possible to do the job with only 32, as indicated by the plan

Since the fuselage sets into the front wing, the center rib is omitted in this case, but the pair marked Z are slanted slightly so as to give a good fit against the lower longerons. The underside of this wing is covered with 1/20" sheet balsa to the wheel strut positions at the ribs marked Y. Wing braces also are attached to these ribs, the third from the fuselage. Give this front wing a dihedral of 1 1/2" under each tip.

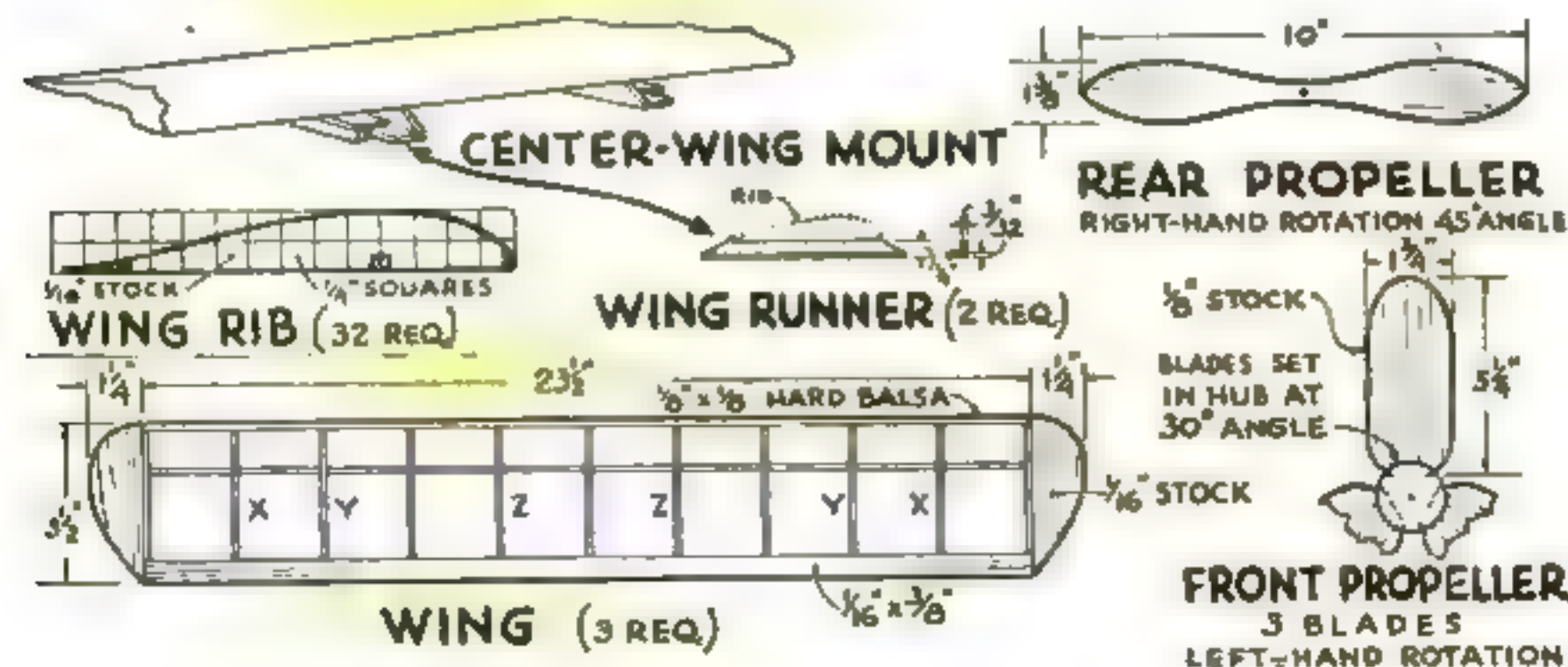
In placing the front wing, make certain that there is sufficient clearance for the cargo door to swing down.

The middle wing is without dihedral. Its center between the ribs marked Z is covered with 1/20" sheet balsa on the underside, and the runners are attached to this.

the three-bladed front one for left-hand operation and the two-bladed rear one for right. Rubber strands comprising the motor are stretched from one propeller hook to the other. If you are flying the plane alone, winding can be accomplished by standing the model on end against the ground and turning the front propeller by hand. If a winder is used, an assistant should hold the rear prop.

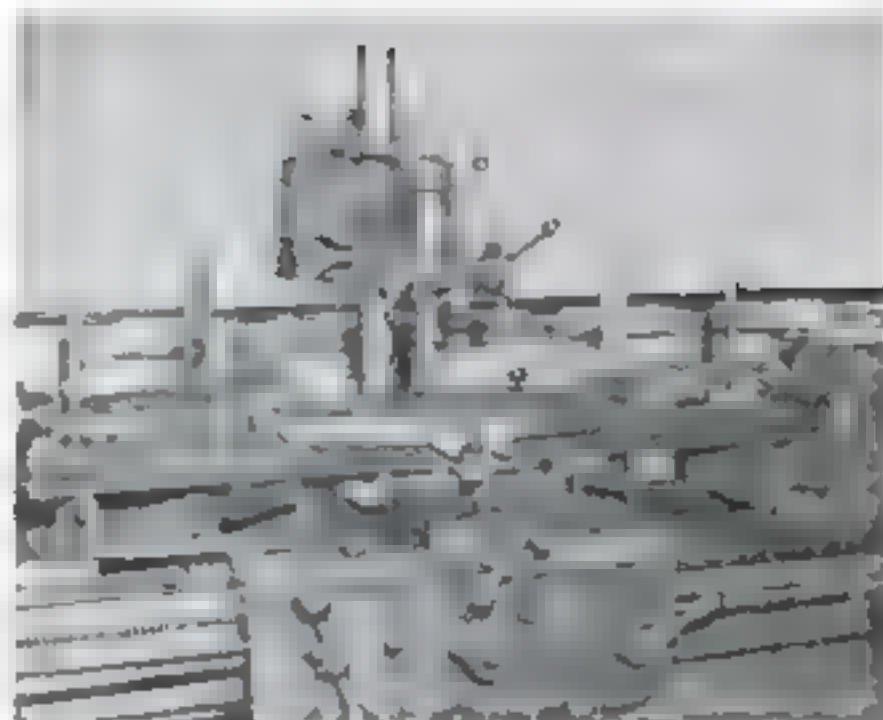
Before trusting the model to areas where it might become damaged, test it carefully over long grass until you have become familiar with its flight characteristics and learn the proper wing settings for various loadings. When flying R.O.G. with cargo aboard, make certain that the latter is securely fastened down, for a galloping center-of-gravity might wreck the model.

One general plan serves for all three wings. Friction will hold the center wing in place on the runners.



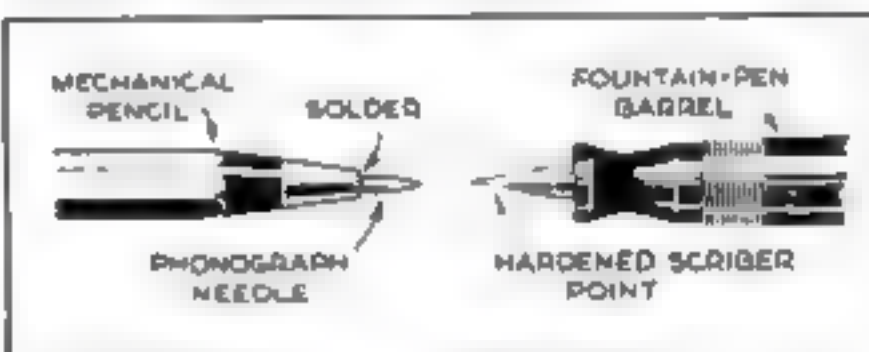
NEW SHOP IDEAS

VERTICAL MILLING in the lathe can be done in an emergency with the aid of a small drill press. In the setup shown, the base of the drill press was bolted to the carriage of a large lathe, two angle irons were cut to rest across the bed inside the ways, a long reinforced plate was clamped to both the bed and angle irons as a table, and a milling cutter was used in the drill chuck. James W. Kemp, of Santa Fe, N. Mex., improvised the machine for milling old-style cylinder heads to provide valve clearance when used on 1945 Fords.



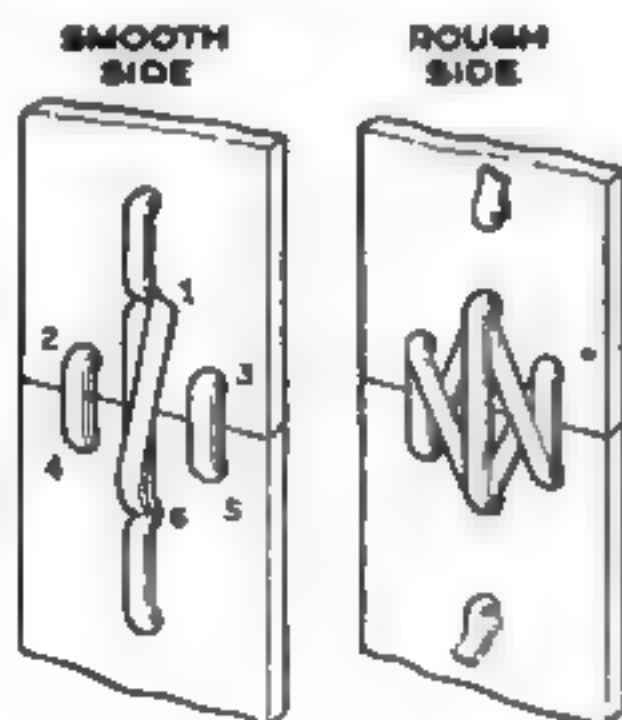
CURVED FILES are sometimes useful for filing a flat surface where a straight file is likely to remove more stock at the edges than in the center. An ordinary flat file can be so curved by heating it to redness and bending it in a vise or with a soft hammer. It then should be rehardened by heating to a cherry red and plunging into water, or into quenching oil for less brittleness.—W. E. B.

OLD PHONOGRAPH NEEDLES are excellent for precision scribing on delicate work when fitted with a suitable holder. One can be made from a discarded mechanical pencil, the opening being drilled out if necessary for the needle to go in. A little solder sweated into the joint will hold the needle firmly. Fitted into the pen-nib hole of a fountain-pen barrel, a turned and hardened steel point also makes a good scriber. Used with the cap, it can be carried in a pocket. GUTHRIE B. STONE.



BELT SPLICING

[SHOP PRACTICE]



Measure the length of belt needed with a steel tape or strong cord over the pulleys, and lay the tape or cord on the belt straightened out on the floor. Mark the belt with a square and cut the ends evenly. Punch at least three rows of holes parallel to the edge, just wide enough for the rawhide lacing, and not too close to the edges of the belt. Three rows are sufficient for a 3" belt, five for a 5" belt, and so on.

Start lacing from the smooth or pulley side to the rough or inside of the belt, crossing the lace on the rough side. The South Bend Lathe Works, in its booklet *How to Run a Lathe*, recommends that lacing start at the holes 1 and 6, with the lace pulled tight and the ends evened up. Then lace alternately in the following order:

6 to 2, and 1 to 5; 5 to 3, and 2 to 4;
4 to 3, and 3 to 5; 5 to 1, and 2 to 4;
4 to 1, and out; 5 to 6, 6 to 1, 1 to 6, and out.

If a pit is used instead of rawhide, the ends may be brought back through 1 and 6 respectively, and then back out through the outside holes, after which they may be tucked under instead of being notched as shown.

POPULAR SCIENCE MONTHLY SHOP DATA

WHEN YOU'RE CORNERED...

Shaped from Odds and Ends, These Handy Little Tools in Delicate Work, and Often Get You Out of a Tight

By WALTER E. BURTON

PICKING up tiny parts and holding them in place for assembly can be a fumbling task at which your fingers prove all thumbs. Or you can use tweezers. Try putting an 0-80 bolt in a model-railway locomotive, and you will see that these little pincerlike implements have a definite place in the shop as well as in the medicine cabinet or on milady's dressing table.

There are, in fact, many different kinds of tweezers that are never seen in a bathroom or boudoir. Some stores carry special tweezers designed for use in making or mending jewelry, model building, watch and

clock repair, and other craftwork where delicate parts are handled or assemblies require working in tight corners.

You can make your own tweezers to fit your exact needs from castoff hacksaw blades or bits of strong, springy wire. A worn-out hand saw will provide material for a dozen pairs. And if you should ram a splinter into a finger—why, you can remove it without leaving your bench.

The photographs on this and the facing page illustrate the steps in making a pair of tweezers having offset tips. They are a variation on normally open, plain tweezers—the ordinary garden variety, most numerous and probably most useful for all-around



1 Stock for a dozen different kinds of tweezers can be had from an old hacksaw blade. Soften a section by annealing and cut it with tin snips.

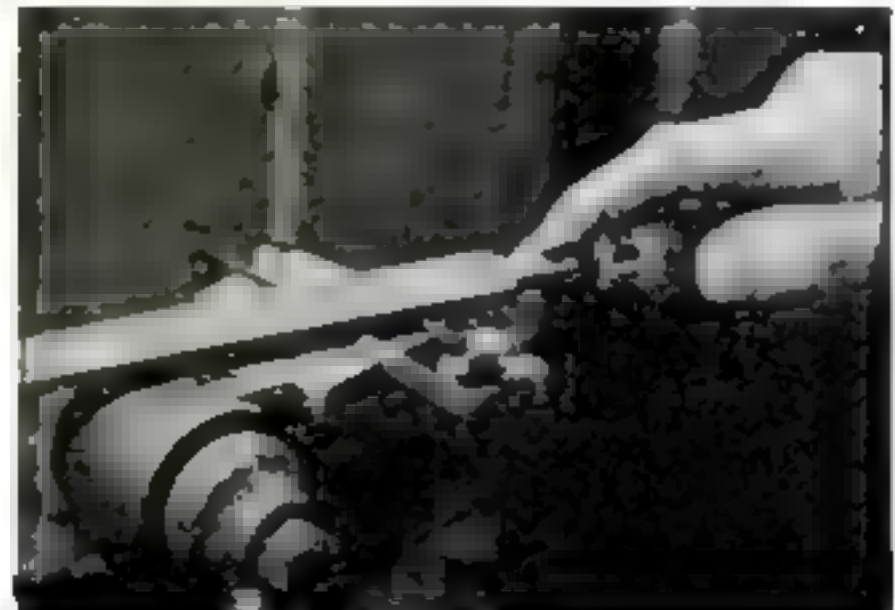


2 Strips of the blade steel are trimmed roughly to shape with snips. The tweezers shown will have offset points good for use in close corners.

3 Holes are drilled and rivets put in (but not peened over in this step) to align the blades for final shaping. Note the claw tweezers in use.



4 The aligned sections are clamped in the vise and filed to almost final shape. Dressing of the tips is left until the rivets have been set.



TRY TWEEZERS

**Serve as Extra Fingers
Spot by Getting into It**

work. Such normally open tweezers can be provided with a locking device that will hold them in the closed position.

Another type is a normally closed pair with tips that remain pressed together until separated by finger pressure—a kind of spring clamp often used for clamping together small parts that are to be glued or soldered. And there are many other possible variations in tweezer design, including size, stiffness of spring action, and shape or position of the tip. Any of those shown can easily be made in an hour or so.

If a saw blade is used, select one that is hard all over, not the kind with a soft body and a hardened tooth strip, for the tweezers



Removing splinters or holding tiny parts, tweezers are needed in a pinch. These have needle points.



5 The tweezers are to be the normally open kind. To give them springiness, the blades are separated, held in a vise, and then bent back slightly.



6 The inner surfaces of the tips are milled by striking a file with a plastic hammer. Only the portion being milled is supported on the anvil.

7 With the rivets reinserted, a large nail set is used to peen them permanently in place. A sheet of soft metal prevents marring of the heads.



8 When the finished shape has been worked with a file and abrasive cloth, the tips are heated to redness and quenched in oil to reharden them.



must have enough strength to be springy. Sheet monel metal, stainless steel, bronze, beryllium copper, and springy brass are metals that are suitable when rust and corrosion must be avoided.

A portion of a discarded saw blade, large enough to provide strips for the legs, was annealed to make the offset-point flat tweezers shown. Many kinds of alloy steels are used for these blades and for hacksaw blades, but most of them can be softened sufficiently by heating to redness and cooling in air. If this fails, try burying the heated stock in ashes or lime to reduce the cooling rate.

You should be able to cut out the strips with ordinary tin snips, as in Fig. 1. The going may be hard at times because these blades usually retain some toughness. Shape the legs roughly with snips (Fig. 2), align and drill them, and hold them in alignment with two rivets slipped in (Fig. 3) but not peened yet for permanent assembly.

Clamp the aligned parts in a vise and file them together to almost the finished shape, as shown in Fig. 4. Then remove the rivets, separate the legs, clamp them as in Fig. 5, and bend them so their tips will be $\frac{1}{2}$ " or so apart when they are reassembled. Next, support only the tips on an anvil or block, one at a time, and roughen them on the inside with the milled edge of a flat file struck a good blow with a plastic hammer, as shown in Fig. 6, to drive the teeth into

the metal. Needle-pointed tweezers are usually left smooth on the inside, but those used for picking up small screws and the like work better when roughened.

The rivets are then reinstalled and peened down tightly, as in Fig. 7. A large nail set will round them nicely, and the heads should rest on aluminum, lead, or other soft metal so they won't be flattened. Final shaping, dressing, and deburring with file and abrasive cloth complete the job except for re-hardening the tips. This is done by heating to redness and quenching in oil, as shown in Fig. 8. Be careful not to overheat the ends. If you have no quenching oil, try a 50-50 mixture of linseed and motor oil. Polish off the oxide scale, and your tweezers are ready for use.

Normally closed claw tweezers are shown in the photos and drawing on the facing page. The two halves are exact duplicates cut from flat stock and notched as indicated. Maximum movement of the jaws is determined by the length of the notches and the angle at which the sections are bent where they cross. Bend the tips to a semi-circular shape by hammering them around a steel rod.

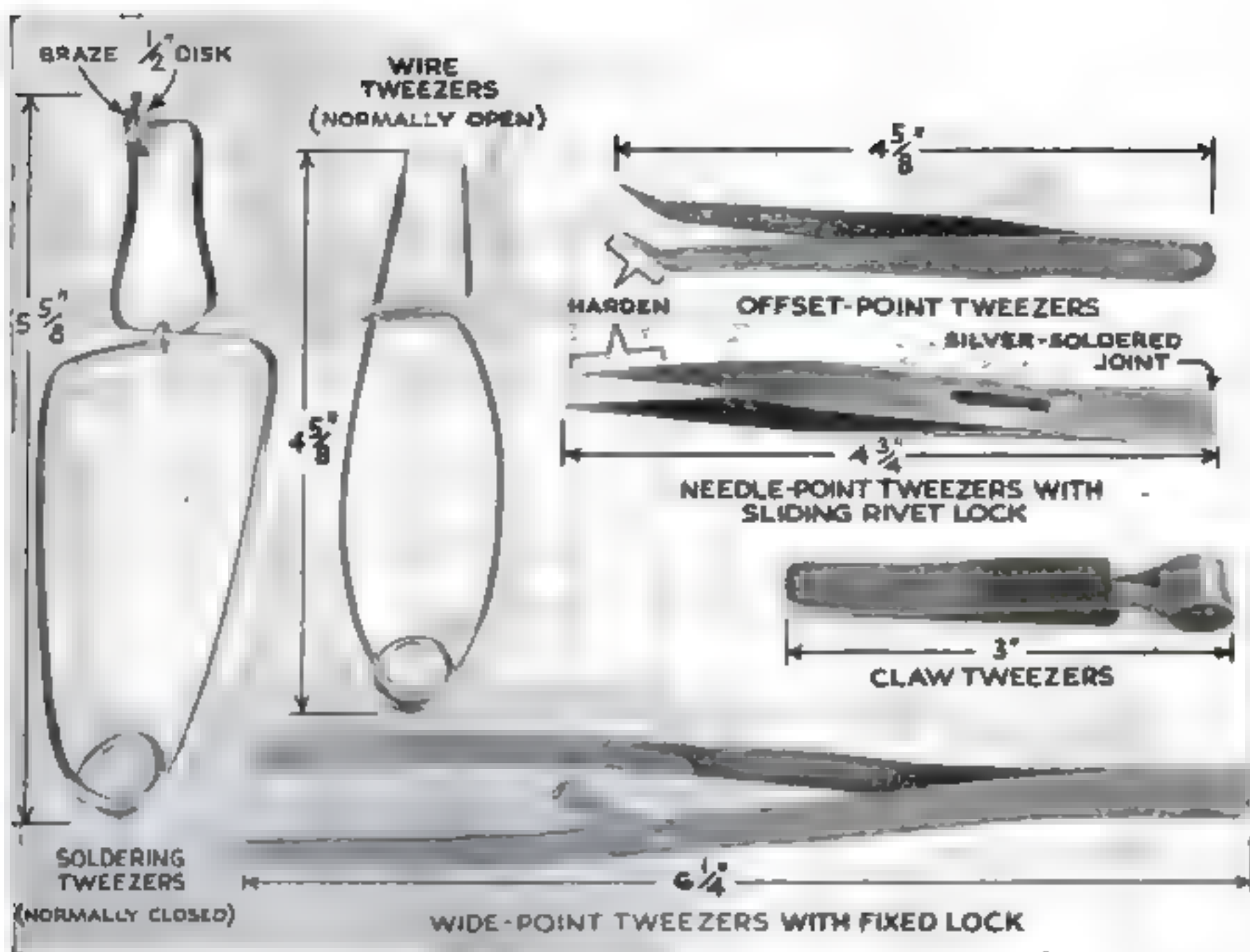
The little 3" claw tweezers illustrated have a great many uses, one of which, gripping small rivets just below the head, is shown in Fig. 8. Builders of model airplanes will find them handy gluing clamps. They may be made in any convenient size.

Tweezers that are normally open may be provided with various kinds of locks to hold them closed on a part being gripped. A sliding-rivet lock is shown on the needle-pointed tweezers in two of the photos, and a hinged-hook lock is shown in one photo. Slot both legs of the tweezers for the sliding rivet by drilling holes to form the ends and removing the intervening metal with a jeweler's saw. Or you can drill a series of holes and file out the slot. The hinged hook is bent from flat stock so it can be moved over the



Three varieties of tweezers are shown here. Above, holding a camera-shutter screw are needle-point tweezers with a sliding-rivet lock. Both pairs at right are made of springy wire. Those being held are brass, and the others, soldering tweezers, are of piano wire.





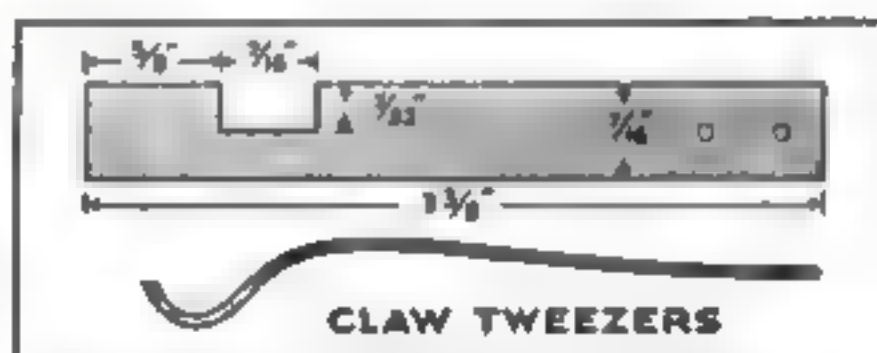
Here are over-all dimensions for a set of small tweezers that will find many uses in the shop. All are homemade of scraps of salvaged metal. The flat pair at bottom is provided with a hinged locking hook.

two blades to hold them together. When not needed, it is swung over one blade.

By far the simplest tweezers to make are bent from springy brass or steel wire. Piano wire is excellent for the purpose. The two shown above and on the facing page are each bent from a single piece of wire. A loop on one leg acts as a guide for the other leg to assure meeting of the points, or a small ring will serve the same purpose. The pair at the left in the photos has normally closed jaws consisting of brazed-on brass disks and is intended primarily for use as a clamp to hold small parts being soldered.

By providing other kinds of jaws, you can adapt the soldering-type wire tweezers to various kinds of clamping work. Jaws made of two ring-shaped loops coming together flatwise are useful for holding fairly large work for soldering or while glue sets. Straight jaws flattened at the ends are suitable for such delicate work as soldering jewelry. And still another type has two squared-end jaws bent to meet endwise.

Many other variations of both flat and wire tweezers are possible. With the designs shown here as a start, you can construct any type your hobby might require.



Claw tweezers are made with two identical notched legs rounded on the end in a vise as shown below.



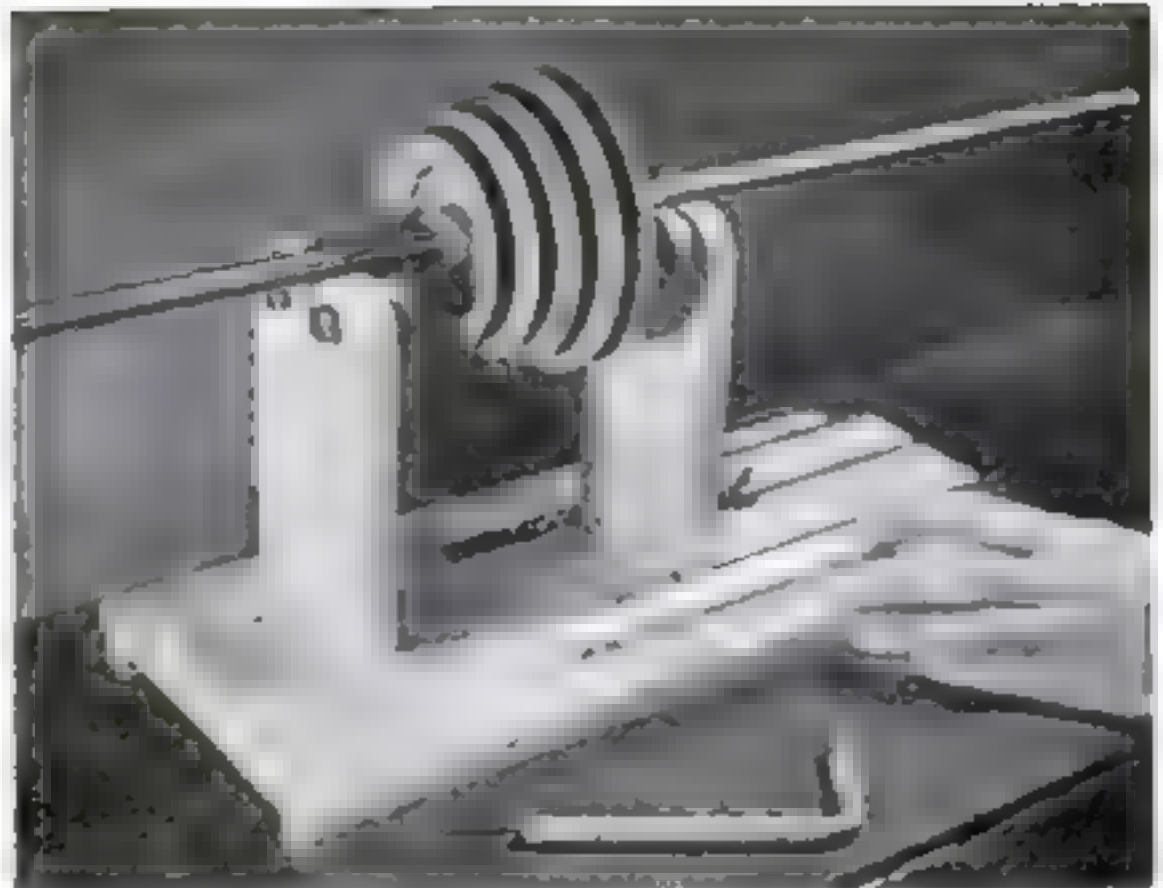
Ball-Bearing Tester Checks Bent Shafts

FOUR ball bearings, five bolts with nuts and washers, and some scrap lumber will provide you with a tester to try the trueness of electric-motor shafts and similar parts. With no more equipment you can also check pulley wheels, armatures, and the like for rough static balancing. The addition of a knife-edge rim to each bearing will increase by a good deal the sensitivity of the static-balance test.

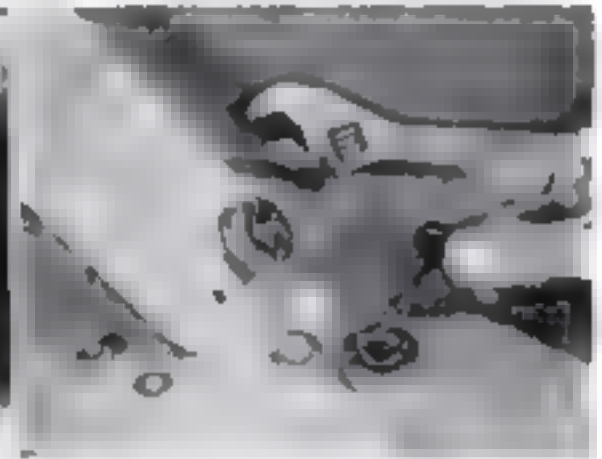
Ball bearings of the sealed type are preferable. They must be free running, so use very light oil when you lubricate them. Mount them on two up-rights, as shown, spacing each pair so their faces will not quite touch. The bearings in the photos are $1\frac{1}{4}$ " in diameter and have a $\frac{3}{8}$ " face and $\frac{1}{2}$ " hole. If you use $\frac{1}{4}$ " mounting bolts, they will allow for lateral adjustment. A washer between each bearing and the wood will permit enough clearance for free rotation.

The up-rights shown are $\frac{1}{2}$ " by 3" by $6\frac{1}{4}$ " plywood. One is mounted permanently on a $6\frac{1}{2}$ " by 14" base. The other is attached to a $\frac{1}{2}$ " by 3" by 6" strip slotted $\frac{5}{16}$ " for most of its length and sliding between two guide strips. A $\frac{1}{4}$ " bolt and wing nut lock it in place.

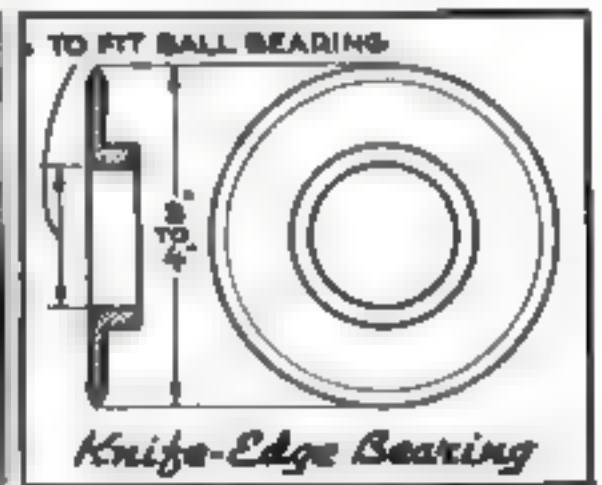
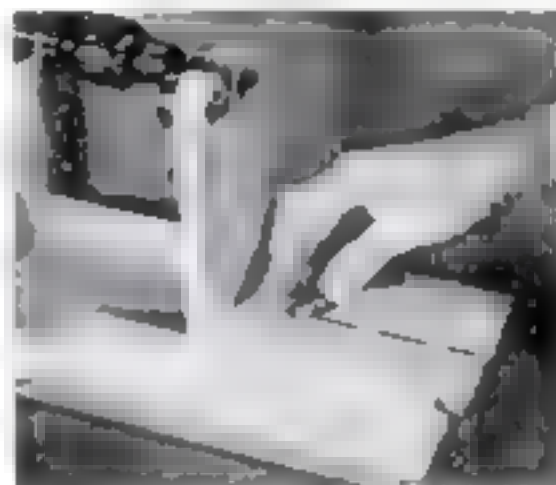
For sensitive static balancing, make the knife-edge rims as indicated in the drawing, using steel that can be hardened. The holes should be in the exact center and a press fit for the bearings, which will have to be respaced to suit the rims.—W. E. B.



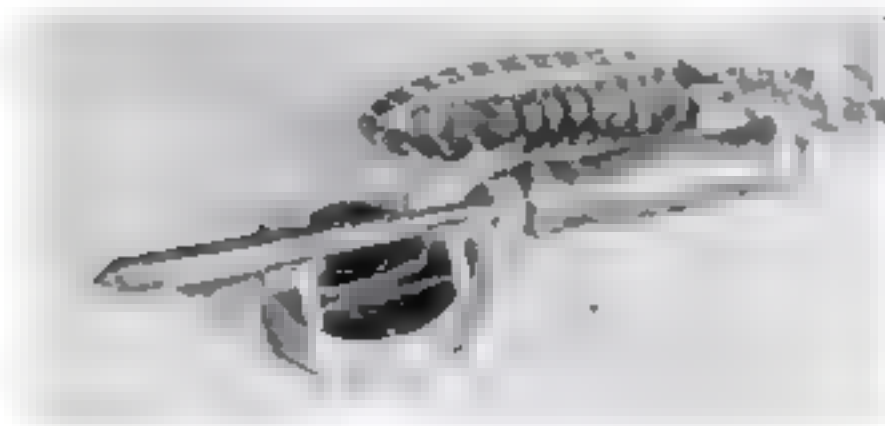
Rotated while its shaft rests on two pairs of ball bearings, an armature, pulley, or the like can be tested quickly for trueness.



The two $\frac{1}{2}$ " plywood up-rights are temporarily fastened and finished at one piece. Bearings are held to them with $\frac{1}{4}$ " carriage bolts.



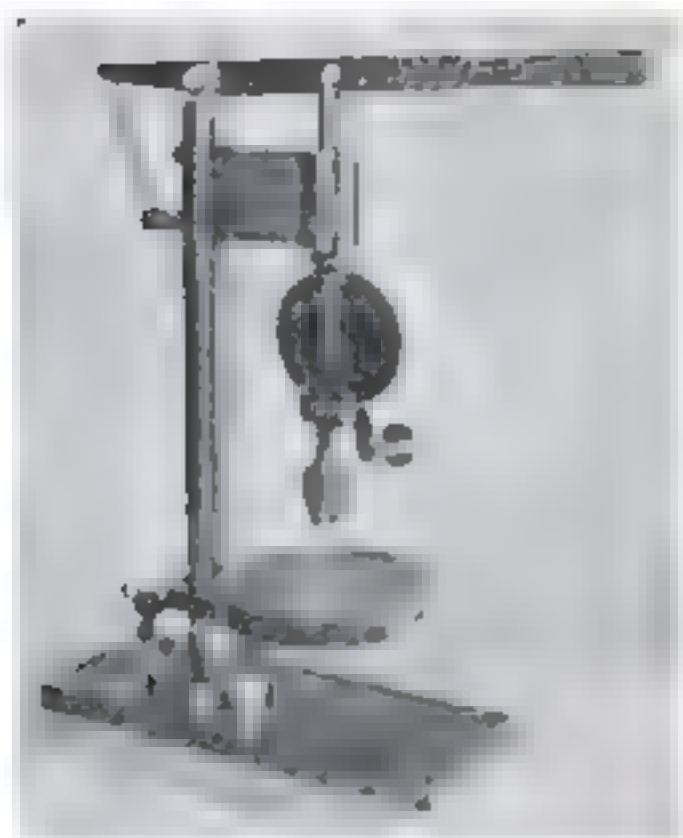
One upright is adjustable in a slot for different shaft lengths. The drawing shows a knife-edge bearing to help static balancing.



Piston Cradles Soldering Iron

SAWED through the wrist-pin bearings, a discarded auto piston will hold a hot soldering iron safely off the bench. If desired, the skirt may be cut away, leaving only the piston head for the base and the bearings for the rest.—C. W. W.

HAND-POWERED DRILL PRESS



HOLDING a hand drill steady at a true 90-deg. angle to the work is next to impossible. But with a small drill-press frame and table built to fit the hand drill used, you have the equivalent of a small sensitive drill in precision. Drill breakage is less likely with such a setup. The hand drill is firmly supported and fed to the clamped work with one hand while the other hand turns the crank. A $\frac{1}{8}$ " hole can be drilled through the inside of the chuck and into the lower end of the spindle so that small drills can be chucked close to the point.

Cut the main column to length, face the ends smooth, and drill and tap the top to receive the forked lever bracket, which is made up separately. Then turn the heavy collar, bore it for a shrink fit, drill for mounting screws, heat it, and drive it permanently on the lower end of the column. Drill and ream the spindle guide also in the lathe. Turn the end of the spindle a drive fit in the bushing, which also fits tightly on the upper stub of the hand drill.

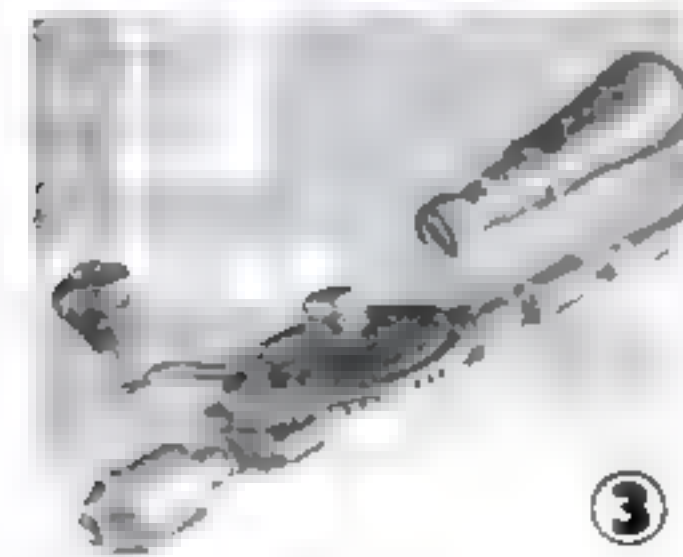
Make the table bracket by boring the hole for the column in one end of a flat piece of steel held in the four-jaw chuck. Cross-drill for the thumbscrew, opening to clearance size halfway and tapping the rest, and split the end with a hacksaw to give clamping action. Holes for two mounting screws are drilled in the table and bracket at the same time. Drill the column for two screws that pass through the spindle bracket and hold the guide bushing.—C. W. WOODSON.



1 With the spindle guide chucked in the lathe, drill and ream to a sliding fit.

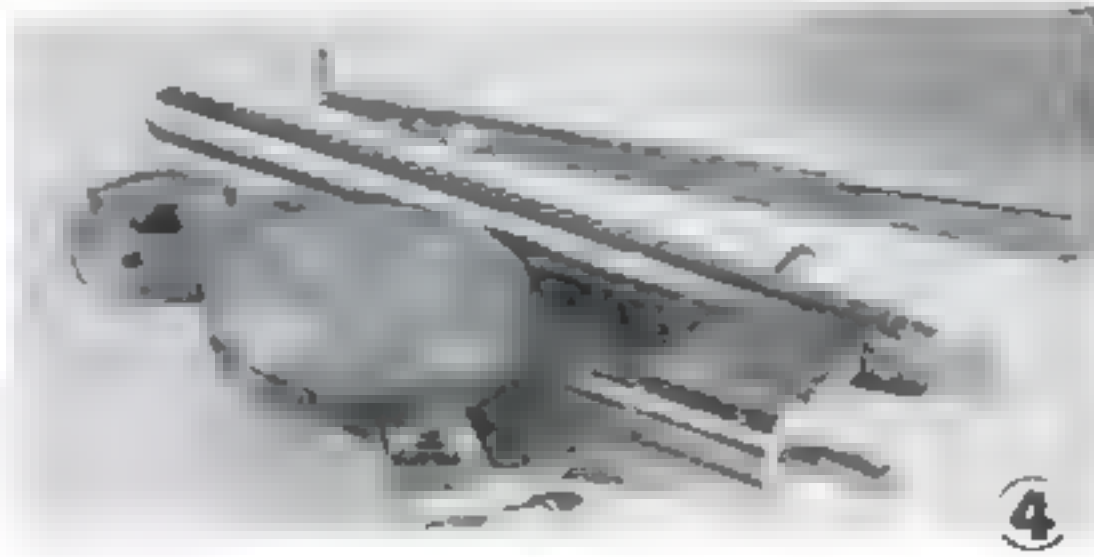
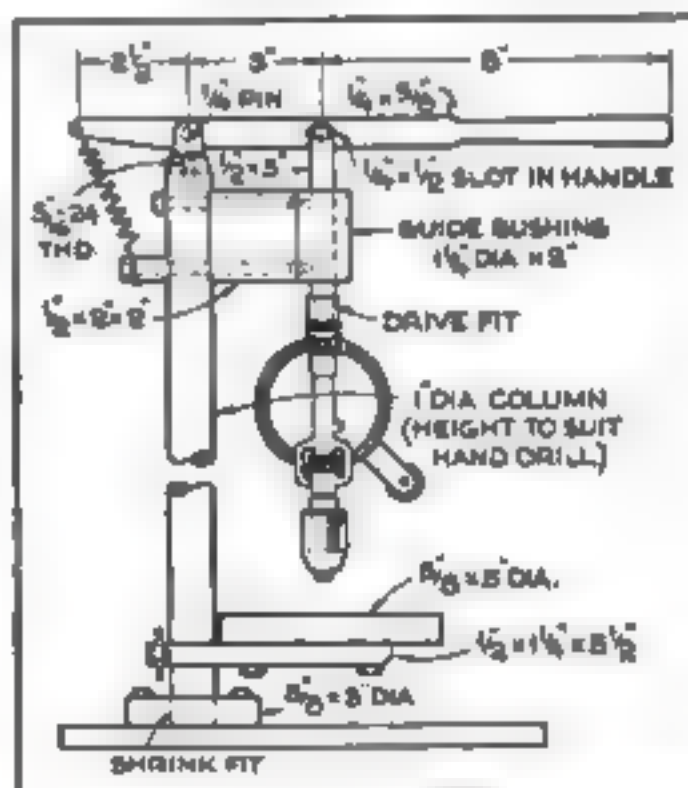


2 A steel disk is faced smooth for the table and drilled for mounting screws.



3 Spindle and drill are put together with a bushing. Turn both to a drive fit.

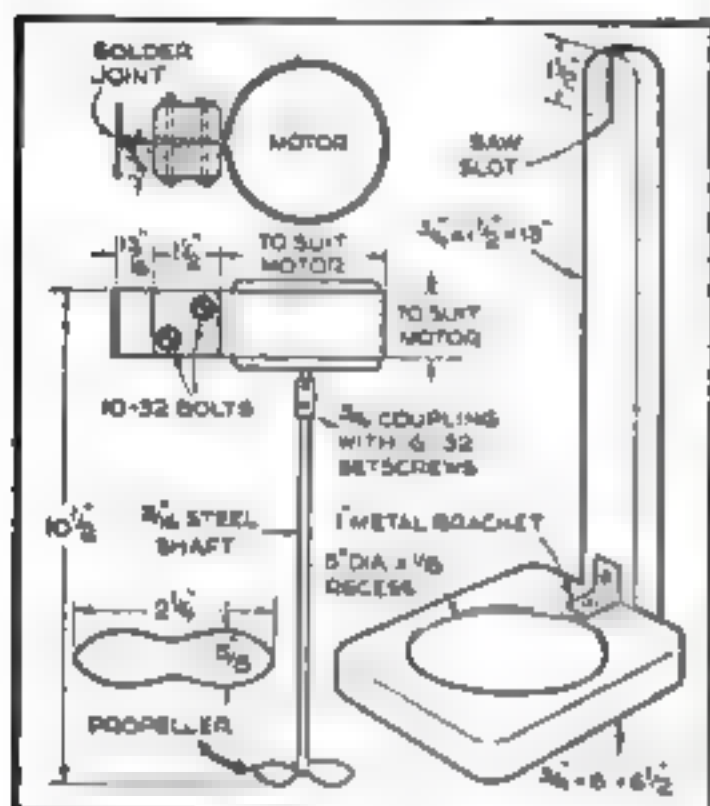
4 Here the bracket is on the table. The column and other parts are also shown.



MOTOR MIXER FOR PHOTO SOLUTIONS



Mixing chemicals is no chore with this setup. The stand is of wood, and a small drink mixer provided the motor shown below.



By WILL THOMAS

PHOTOGRAPHERS will like this handy little solution mixer, which will dissolve photo chemicals about as fast as they can be weighed and dropped into the vessel. The one pictured uses a kitchen drink-mixer motor, but a motor taken from a hand-type hair drier or a boy's building set would do equally well. Don't use a large universal motor of the kind found in vacuum cleaners; it would be too heavy and powerful.

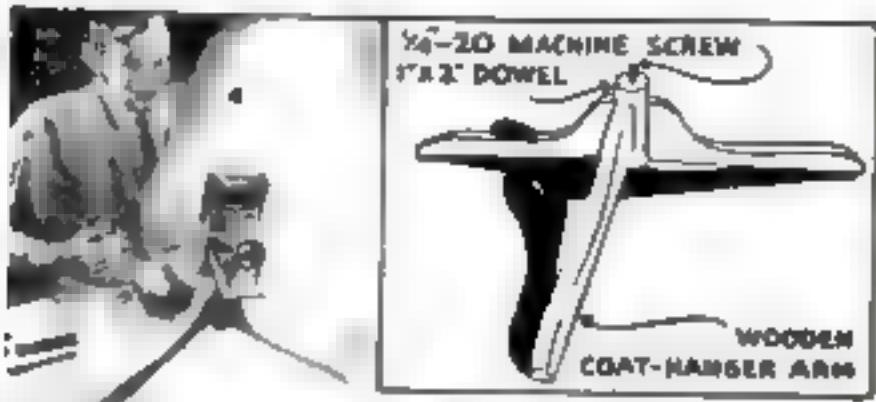
The mixing vessel should be selected before the stand is built. While the iced-drink pitcher shown may not be as professional looking as a graduate, it does have some practical merits. It is widely available and costs little, it holds over two quarts, and the handle makes it easy to use when filling bottles. The lip pours well and its two large wings can, if desired, be used to hold a wad of absorbent cotton for straining a solution.

Dimensions in the drawing may of course be altered to suit the particular motor and vessel selected. The principal requirements are that the motor clear the vessel by several inches, that the propeller shaft be centered within, and that the propeller blade

be about 1 $\frac{1}{2}$ " from the bottom. Use $\frac{3}{4}$ " stock for the base, recessing it to keep the vessel from moving. The upright, slotted at the top to hold the motor mount, is screwed to the base with an angle bracket.

The motor mount is made by drawing a band of sheet metal around the motor and clamping it tightly between two bolted wood blocks. Bolt holes in the band should either be oversize or filed into slots to permit easy adjustment. The ends of the band pass through the slot in the upright and are bent out at right angles, and solder is run into the vertical joint. The completed mount should drop into the slot without wobble.

A sleeve coupling, tapped for two 6-32 screws, attaches the propeller shaft to the motor. Stainless steel is best for the shaft and propeller, but ordinary steel (or even solid curtain rod for the shaft) will do if it is wiped dry after use. Hacksaw a slot in the lower end of the shaft and solder in it a small sheet-metal propeller. Adjust the blades by bending to force the solution toward the bottom of the vessel, and determine by experiment the pitch that affords maximum turbulence without splashing or overheating the motor.



Three coat-hanger arms glued to a dowel make a tripod for taking your table-top pictures.

FOR A TABLE TRIPOD to be used in table-top photography, three halves of wooden coat hangers serve admirably. Rasp the inside ends concave to fit around a 1" by 2" dowel. Bore an undersize hole part way into the top of the dowel and thread in a 1/4"-20 machine screw, which fits most cameras, cut the head off, and file the burrs on the end threads smooth. Then glue and screw the legs to the dowel 120 deg. apart. Use washers if necessary to hold the camera snugly at a point where the lens comes between two legs. To tilt it, place books under one leg.—FRANK SHORE.

DOZENS OF PRINTS ARE WASHED at one time in the tank shown below, which was made from an ordinary galvanized tub. Incoming water flows against the side and swirls the prints for thorough, efficient washing. An overflow pipe, protected by a baffle, keeps the water from rising too high and the prints from collecting at the edge or going over the top.

Drill or punch an inflow hole near the bottom and solder into it a length of copper or other nonrusting-metal tubing with an inside diameter that of the hose to be connected to the water supply. Next, drill an outlet hole at the desired water level and

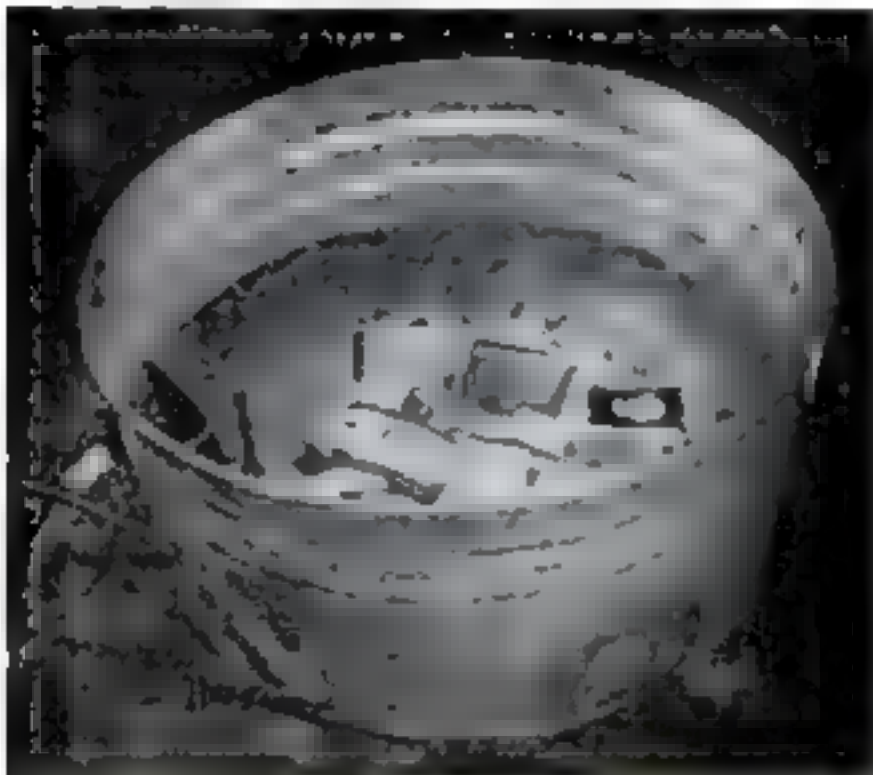


PHOTO IDEAS

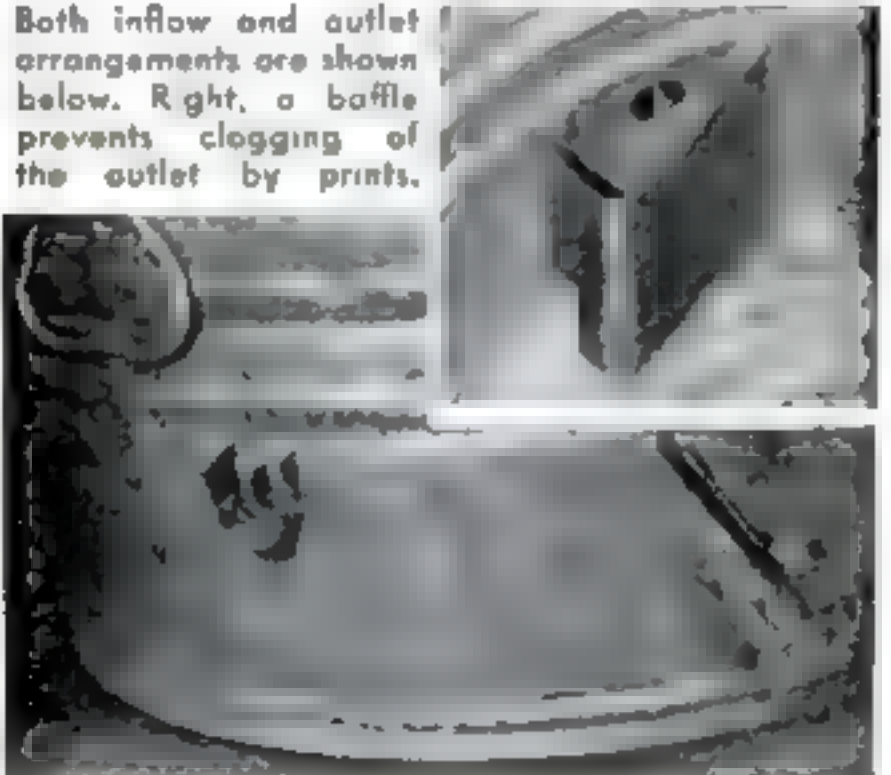
AN INEXPENSIVE SAFELIGHT is made easily from a pint-size waxed container and the ruby glass from an auto tail lamp. Cut a hole in the lid to fit the glass, which is held in with tape, and punch a hole in the bottom for an electric cord. Put a 7 1/2-watt bulb in a socket inside, plug the cord hole to be certain no light will escape, and replace the lid with the lens in it.—H. K.



solder on the outside a U-shaped trough to direct the flow clear of the tank. Then solder a baffle on the inside at the overflow hole to prevent clogging by the prints. The baffle should extend above the overflow hole, and a small section should be cut out at the bottom of the baffle to admit the hypo-laden water.

Smooth all edges of drilled holes and other rough spots with emery cloth to keep the prints from snagging. Connect the hose to a faucet, place the tank near a suitable drain, and you are ready to wash your first prints as soon as the water reaches the proper level.—GEORGE T. LUNDEEN.

Both inflow and outlet arrangements are shown below. Right, a baffle prevents clogging of the outlet by prints.





Use of a figure adds interest. The scene was taken on Ansco Superpan Press film pack with a K2 filter.

SNOW PICTURES

Good Exposure and the Right Filter Provide Keys

By GLENN R. KERSHNER

*Popular Productions,
Samuel Goldwyn Studios, Hollywood*

MANY charming scenes await your camera when snow blankets the fields, caps the fences and barns, and sweeps on to the horizon. A grotesque, leafless tree or the myriad shadows cast by its branches may appeal to your sense of the dramatic. Or you may like full-textured close-ups of snow patterns themselves or the wide sweep of a landscape. Snow and ice always fascinate me—the fast action of sleds racing down steep hills, ice-covered falls in mountains, and frost-covered trees along a country lane.

Making really excellent pictures of snow and of objects in snow takes ingenuity and adds enticement to the art of photography. The primary problem involves the subject matter itself, which, though you may not think so at first, has comparatively low

brightness range instead of the dark shadows and bright high lights that your eyes see. The fact is that the brilliant reflection of the millions of snow crystals causes considerable radiation of light, and this tends to flatten the contrast by filling in the existing shadows.

Another point apt to be overlooked is the frequent presence of certain predominant hues. These are shades of pale blue and white. Bright reds and yellows are greatly subdued or completely lacking.

Fortunately, effective contrast can be increased easily by the use of yellow contrast filters. They have two effects—by absorbing scattered blue radiation, they strengthen the shadows, and they darken the sky. Usually a medium-yellow filter serves this purpose satisfactorily, though occasionally only an orange, or perhaps a red, will give the maximum effect desired.

Snow scenes can often be strengthened



Shadows and sky were darkened by a K2 filter in this photo. Side lighting helps to give the snow texture.

THAT SPARKLE

to Winter Photos Your Camera-Wise Friends Will Envy

by the inclusion of figures or objects either in the foreground or background to add a point of interest that might otherwise be lacking in a pictorial composition. Since it is difficult, even impossible sometimes, to obtain pleasing detail in both the over-all scene and the figure, you can simplify the problem by trying only for the best picture of the scene itself. Probably the figures will then appear in dark silhouette against the white background, but they will serve their purpose by lending added interest to the general scene.

Good texture is sometimes the most important part of snow photography. Proper rendition is generally the function of proper lighting. Conventional illumination, with the light coming from behind the camera, is almost never of value for capturing snow texture. Instead, you should depend on strong back and cross lighting.

Flare, caused by scattered radiation and

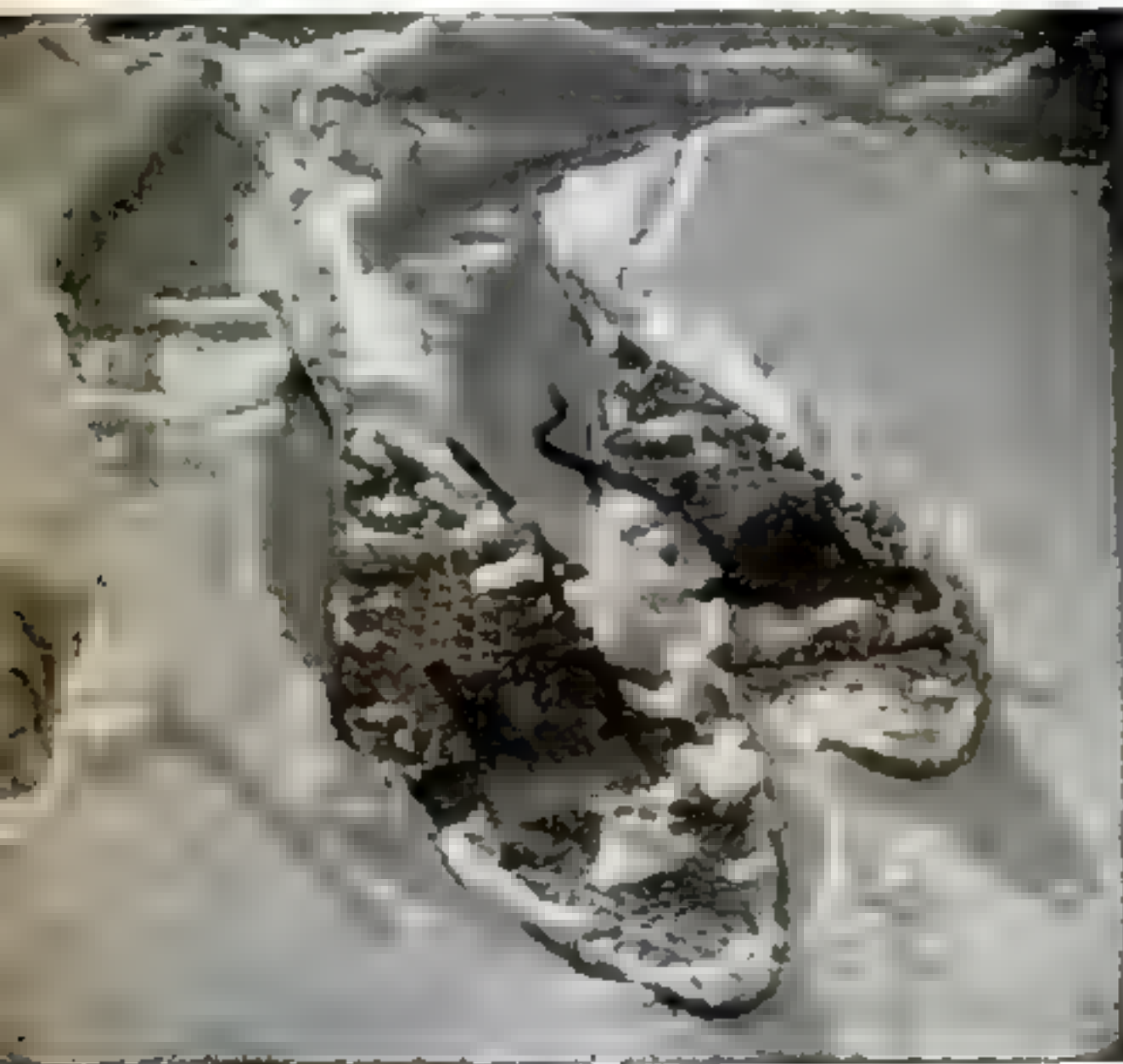
resulting in loss of contrast and detail, is no problem if a lens shade is invariably used. Make sure that no condensed moisture fogs the lens, and watch the shutter for variation from normal speeds sometimes occurring at low temperatures.

Both correct exposure and film development are extremely important, even more so than in other types of photography. The film used should possess the characteristics of long-scale, brilliant gradation and high color sensitivity to make effective the use of filters. And the emulsion speed should be high to permit short exposures and small lens openings even when filters are employed. Panchromatic film is generally preferred, though an orthochromatic film is sometimes satisfactory.

Your filter needs for snow pictures can be met by yellow, red, and green filters, with the possible addition of amber and neutral ones. Instructions for their use, including



Snow is both setting and prop for the fetching result in the view above. Note how well the snow texture is captured in the snowshoe close-up below, made on Ansco Finopan film with a Wratten G filter.



what is known as the factor number, will be found on the box. The letter *P*, which may precede the designation, simply means that the particular filter has been corrected for panchromatic film. The factor number tells you by how much, if at all, you should open the diaphragm compared to its normal setting for the same picture without a filter. What is known as a "two-time" filter, or one having a factor number of 2, requires an opening one stop wider than normal to compensate for light held back by the filter; a "four-time" filter, factor number 4, requires an opening two stops wider. In figuring diaphragm settings, remember that you double the exposure each time you open the diaphragm by one full stop. Of course, you can instead use a slower shutter speed to obtain the necessary increase in exposure.

Here's what some of the most frequently used filters will accomplish: Very light amber filters have a slight color correction for all panchromatic films, produce slight contrast, penetrate slight haze, and help to snap up faces. Ordinary light amber filters give normal correction for all types of panchromatic film, produce medium contrast, darken blue sky a few shades, bring out clouds, and penetrate haze more deeply than the very light ones. Yellow filters give full color correction, produce more contrast than amber, and are excellent on open landscapes. They darken sky slightly, strengthening the clouds, lighten all yellows, oranges, and reds, and lighten green and magenta slightly.

Light-red filters produce medium overcorrection, darken blue sky and water for night effects, lighten faces, darken greens slightly, and lighten anything red or yellow. The overcorrections of very deep red filters convert brilliant snow into night scenes, turning all faces and

red clothing white as though flooded with moonlight.

Green filters have a strong softening effect, producing green and yellow contrast. They are excellent for use on landscapes and snow, provided sky is avoided as much as possible. Neutral filters are another type sometimes used by professionals. They produce a medium softening of glare and contrasts.

In combination, light-red and green filters darken sky, bring out clouds, lighten faces, and soften both the white of snow and the shadows. When two such filters are used in combination, be sure to add their factors together and open the lens the full number of stops indicated by the total. Thus, if the factor of one is 3 and of the other 5, the combined factor would be 8 and the lens would have to be opened three full stops. It is possible to get a night effect in full sunlight with this combination by opening up only $1\frac{1}{2}$ stops instead of three.

Some filters are supplied in combination by the manufacturer. One such is a combination of the ordinary light amber and a medium neutral one. It gives moderate color correction without excessive contrasts and also softens strong glare. The combination is very satisfactory on snow scenes, and it gives pleasing values when used on open-water scenes.

When the very light amber filter is used in combination with a neutral one, the amber corrects clear blue sky slightly and the neutral slightly softens the whites. It is an unusually satisfactory combination.

Only a word need be said about taking snow pictures in color. You require no filters for this. If properly exposed, your pictures should be good. Simply take careful meter readings and follow the instructions provided with your film, remembering that accurate exposure is important.



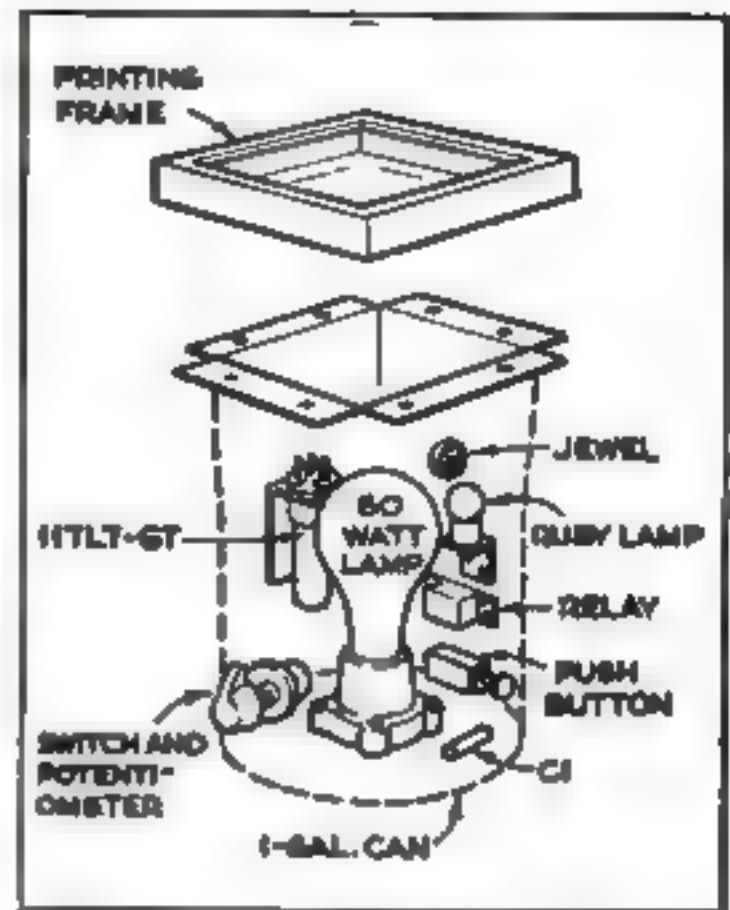
Excellent texture in the tree trunks and the snow is captured in the photo above largely as a result of proper exposure and cross light. Below, brilliant reflection from the snow crystals tends to flatten contrast by filling in shadow instead of producing the dark shadows and bright high lights that ordinarily are expected.



ELECTRONIC PRINT TIMER



Any lighttight box can be used for this timer, but the fruit can is big enough if the parts are properly laid out. The drawing, right, shows a practical arrangement.



THOSE who go for canned fruit in a big way, or can get a 1-gal. fruit can from a boarding house, have a good photo accessory at hand. Such a can is lighttight and just the right size to hold this electronically controlled contact printer.

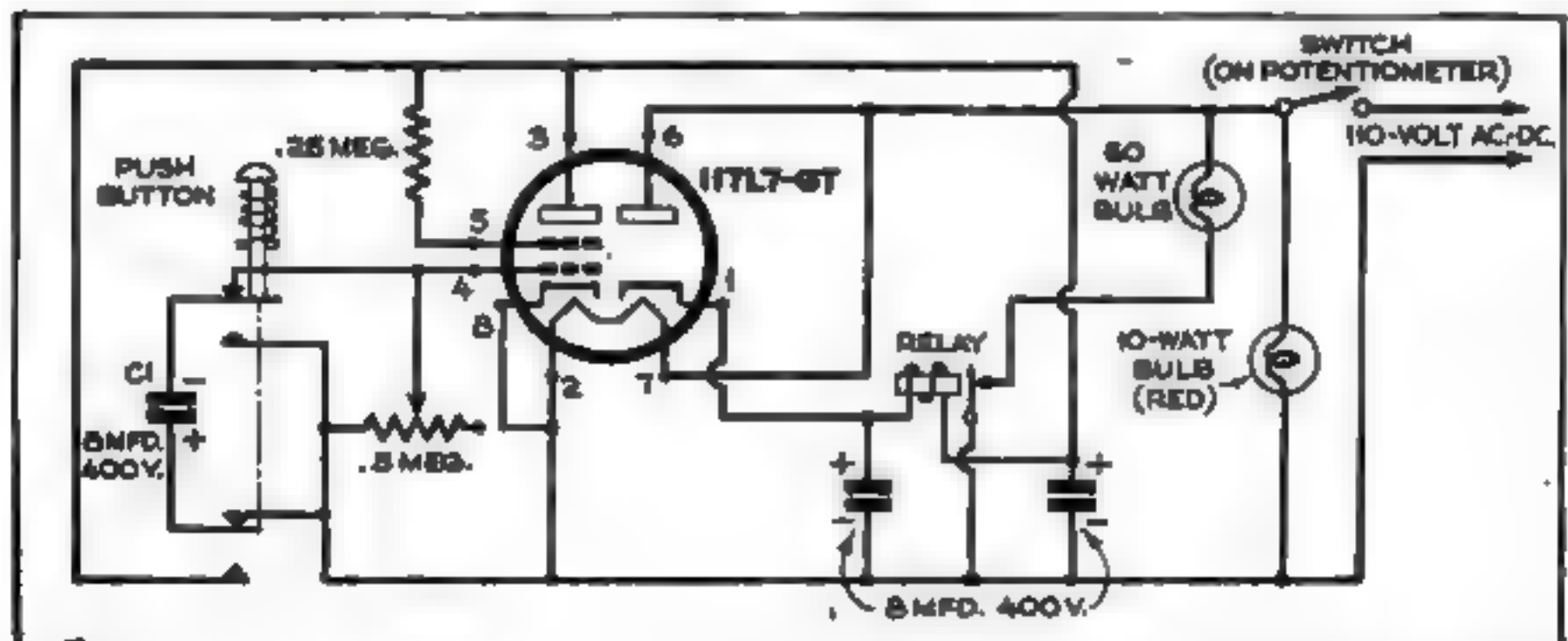
Bend the opening into a rectangular shape and mount a standard $8\frac{1}{4}$ " by $5\frac{1}{2}$ " printing frame as shown. A hinge between the frame and pressure plate completes the photographic part of the job. Chief components of the timer are a 117L7GT vacuum tube, a linear .5-meg. potentiometer with switch, a double-pole, double-throw pushbutton switch, and any fairly sensitive, normally energized relay rated at around 10 millamp. and 2,000 to 3,000 ohms.

Mount and wire the parts as shown. To calibrate the timer, turn the potentiometer clockwise until you hear the snap of the

power switch. Both bulbs will light, but after the tube starts to warm up it activates the relay and cuts out the exposure light. Allow a few more minutes for the tube to get into proper operation, set the potentiometer about half way, and press the push-button switch for one second.

The exposure lamp should go on and then turn off automatically. Using a stop watch, time the length of exposure for various settings. Each time you get an even-second exposure, scribe the position of the knob on the can. The maximum time of this unit is about 15 seconds; for a longer maximum, increase the capacitance of C1 or the resistance of the potentiometer.

By plugging the line cord of your enlarger into the exposure-lamp socket, you can make the timer keep watch over your larger prints as well.—KARL GREIF.





WASHDAY IN THE PACIFIC



AMERICAN troops stationed at remote posts in the Pacific contrived many ingenious power laundries. Most of these washers were crude affairs, but all were better than grandmother's corrugated washboard and tub—or a GI bucket filled with water.

Windmill washers appeared on a number of islands, motive power being furnished by the brisk breezes which swept over the sand and coral. Pfc. R. F. Purdum, of Dewey, Okla., built the one shown above at the left. An old oil drum served as his tub.

But at many bases wind power was not particularly reliable. So mechanically minded GI's looked around for a gasoline engine or electric motor they could put to work.

Every man in Sgt. Mel Klausner's company in New Guinea used the laundry shown



above at the right. The sergeant, known to his comrades as "Tom Swift" because of a number of labor- and time-saving inventions, hooked up a $\frac{3}{4}$ -hp. motor with the gears of an airplane-engine inertia starter obtained at an Air Corps salvage dump, and attached to the gears a special shaft which extended into a GI bucket on the floor below. When the sergeant filled the bucket with soap and water—and clothes—the results were so good that the machine practically never got a rest.

Seabees at another Pacific jungle base set up the imposing laundry below. A one-cylinder air-cooled gasoline engine provided the motive power in this case, and oil drums again came in handy. The clothes got a good shaking up in the one made to serve as the actual washer. Others were cut down to provide rinsing tubs.

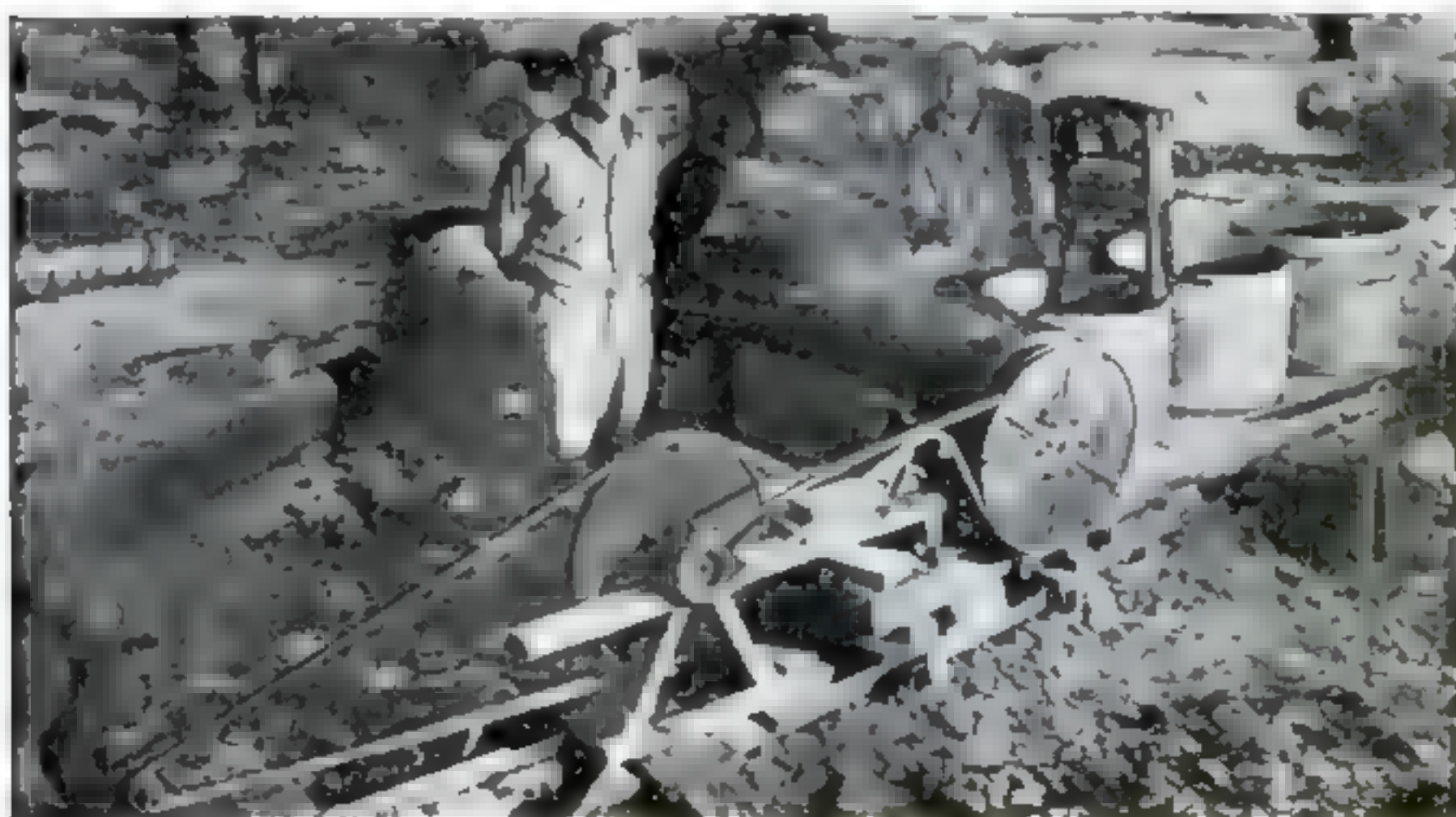




Photo by U. S. Army Signal Corps

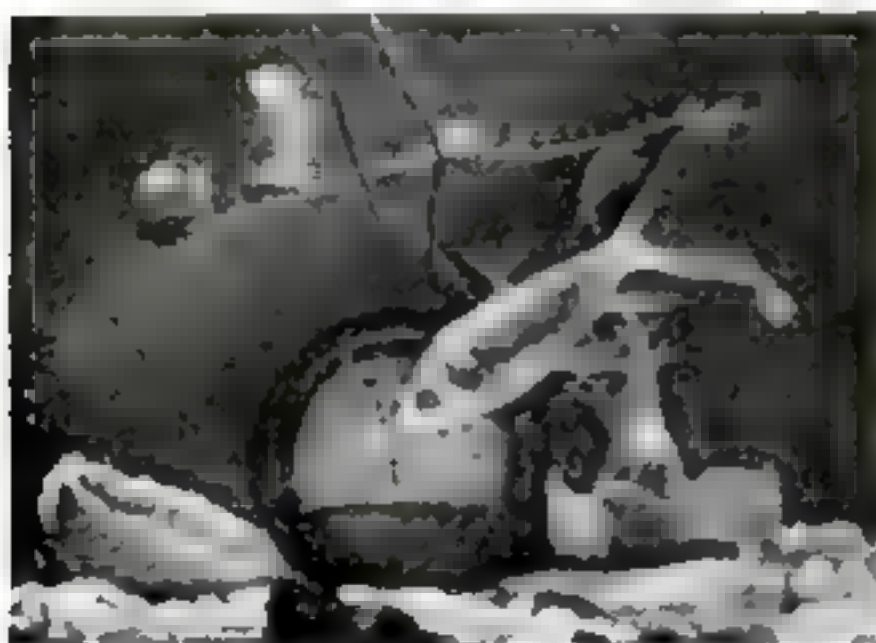
DIRECTIONAL RADIO RELAYS with weatherproof equipment in stations every 25 miles or so have been developed by the U. S. Army Signal Corps as a means of speeding communication. All have multiple channels. They are known in Army nomenclature as AN/TRC-1, 5, 6, and 8.

The latter two employ the new pulse-position modulation with time-division multiplexing. In pulse position radio-frequency

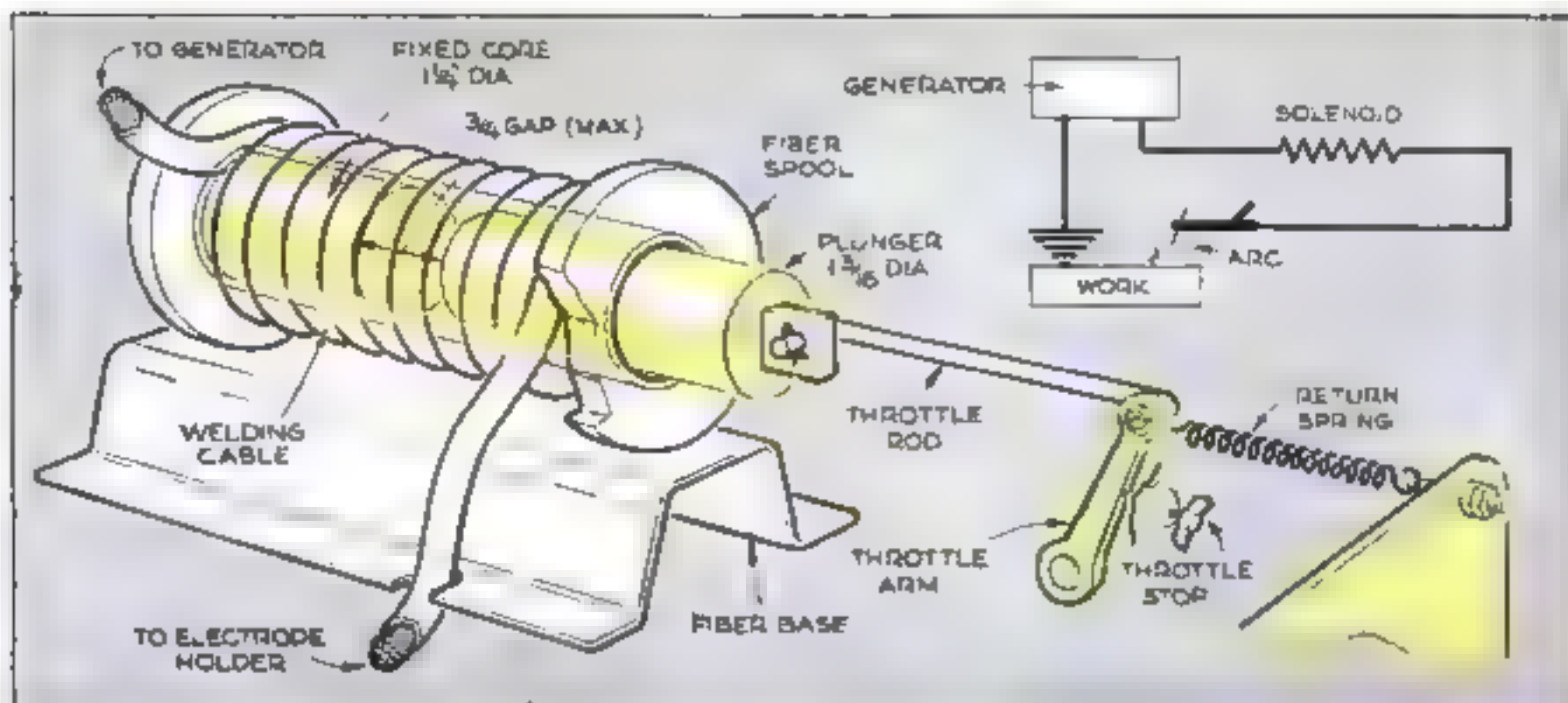
waves shoot out in microsecond bursts, not continuously as in A.M. and F.M. Eight simultaneous conversations are chopped into bits and are fitted back together at the receiver. The frequency range of AN/TRC-6 is 4,300-4,900 megacycles, that of AN/TRC-8 is 1,350-1,450 megacycles.

AN/TRC-1 and 5 are F.M., the former at 70-100 megacycles, the latter 230-250 megacycles. Each carries four phone circuits.

HERMETIC SEALING of electric instruments has been brought to the point where they perform even in a goldfish bowl. General Electric has perfected a method that seals instruments against humidity, dust, fungus, and discoloration as well as water. In tests instruments so sealed have been submerged, and also subjected to temperatures ranging from 67 deg. below zero to 185 above.



BEDSIDE SWITCHBOARDS that can handle two calls at one time connect directly with the nearest long-distance center to relieve regular switchboards at Army hospitals. The portable device, built by the New York Telephone Company, plugs into a wall jack.



Solenoid Governs Welding Generator

A SENSITIVE governor for homemade gasoline-driven welding generators may be built on the solenoid principle, as shown above. When the arc is struck, current flowing in the coil draws the plunger toward the fixed core, opening the throttle for the increased load; when the arc is broken, a spring returns the throttle to the idling position. The fixed core should be a soft iron rod $3\frac{1}{2}$ " long and the plunger a similar piece about $4\frac{1}{2}$ " long. Wind the solenoid with about 10 turns, using either the cable itself or wire of the same rating.—A. CRUICKSHANK.



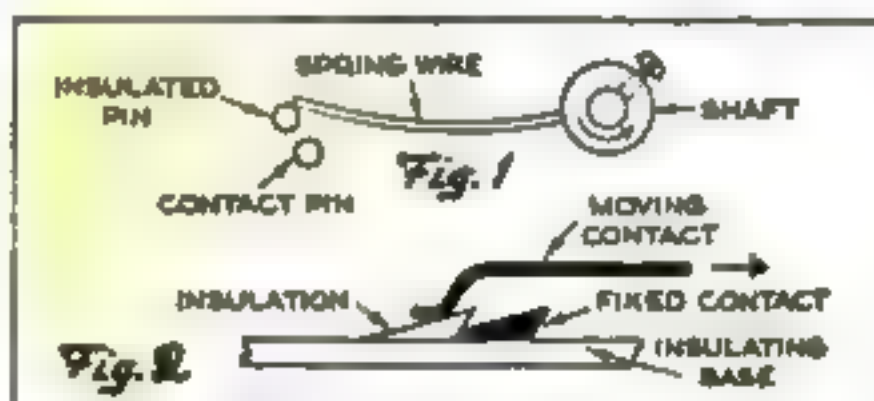
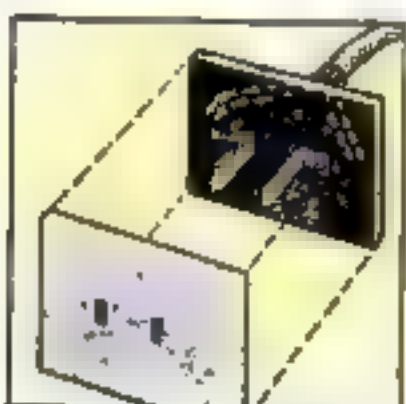
Hookups Insulated by Pushpins



GLASS pushpins will serve as handy stand-off insulators for experimental electric hookups. They are particularly useful in "breadboard" rigs, for they can readily be located exactly where needed.—H. K.

Flat Plug Made from Shoe Sole

TO PERMIT hanging an electric clock flush with the wall, I made an extra-flat plug from a dime-store rubber shoe sole. I cut two pieces about 2" by $2\frac{1}{2}$ " and made two slots in one and two holes for wires in the other. The prongs were spring-bronze strips, about $\frac{1}{4}$ " by 1". After the wires were attached, the pieces were cemented and taped together.—T. S. S.



Snap Action for Slow Contacts

WITH time switches and other devices employing slow-moving electrical contacts, the slowness of the action sometimes causes arcing or chattering of relays. A light rotating contact, such as might be used on a clock shaft, can be given a snap action as shown in Fig. 1. A length of spring wire on the shaft serves as the rotating contact; it passes two pins, the first insulated and the second a stationary contact. The first pin holds the spring wire until sufficient torque has developed to snap it past to the contact.

Sliding contacts may be improved by providing an insulated ledge from which the moving contact snaps onto the fixed contact (Fig. 2), giving quick, positive closure of the circuit. A ledge on the contact itself affords a quick break.—D. H. MATHESON.



Radiant power is only part of the wonder of a Tesla coil. When brought within the field of the energized coil, an ordinary bulb glows with a strange violet light as rosy streamers shoot out from the filament.



Is this the lighting of the future? The young lady's reading light consists of a fluorescent tube without wired connections. The Tesla coil that powers the tube is located in another room, but plain walls are no obstacle to its energy.

Wires of small diameter can't confine the high-frequency currents generated by the Tesla coil. Current leaps out of the wire sandwiched between the glass plates, making it glow in the dark.



Cigar-Box Tesla Coil

WORKS WEIRD WONDERS

By Tracy Diers

"IS THERE, I ask, can there be a more interesting study than that of alternating currents?"

With this question, put to a group of outstanding engineers and scholars more than half a century ago, Nikola Tesla opened an address and an epoch. These words ushered the leading scientists of two continents into a veritable fairyland of crackling brush discharges, indescribably beautiful gaseous glows, and space-spanning energy that wires could not confine.

On that historic night, young Tesla brought into public view the wonders of high-frequency, high-voltage alternating current (H.F.H.V.A.C.). Its source was the now famous Tesla coil.

A Tesla coil is a transformer used for stepping up medium-high voltage, H.F.A.C., to fantastically high voltages. By following the instructions given on the next page, you will be able to construct a coil capable of producing all the effects described in this article. "When your coil is complete, close the filament switch. Ten seconds later, close the high-voltage switch. Immediately a 2½" arc will leap from the high-voltage terminal into the surrounding air. If it doesn't, the primary coils are probably bucking, and either one should have its connections reversed.

The things that this corona can and will do are legion. Two of them are illustrated by the four photos on page 193. For experiment No. 1, your equipment consists of a stiff horizontal wire supported on a free-moving metal spinner. If the wire is coated with shellac along its entire length so that the corona can discharge only at the tips, then when the H.F.A.C. rushes into the wire, it will drive it merrily—and luminously—around.

Experiment No. 2 demonstrates the ineffectiveness of glass to resist the hot electrical energy that bursts forth from the Tesla coil. One of the two metal rods of the spark gap goes to the high-voltage outlet; the other returns to ground. Both are shielded from any mid-point contacts. When the gap operates smoothly, insert a sheet of ¼"

High voltages don't like to be fenced in. It's a serious problem for engineers, but for Tesla-coil experimenters the corona, right, is a welcome sign.

plate glass—and watch the spark continue right through.

Notwithstanding these facts and its terrifying appearance, the corona is quite harmless. If you hold a copper rod in your hand and bring its free end close to the discharge, the current will jump to the rod, and race via your body back to ground. But you won't even feel it!

Not enough current? Don't kid yourself! While it is true that the power output of this coil is not very high, 50,000 volts at the current you have here would normally ferry you into another world. Safety lies in the frequency of the current, which is well above a million cycles a second. All high-frequency currents travel on the surface of conductors; when you are the conductor, your skin carries the current and your internal organs aren't affected.

A much more strikingly visual proof of this phenomena is shown at bottom right on the facing page. Since H.F.A.C. insists on traveling only on the surface of conductors, these conductors may be hollow pipes instead of wires, but they must have



surface area—lots of it. If you try to conduct high-frequency currents through fine wires without enough surface area, the current will leap clear into the surrounding air, causing the inadequate wire to glow with a ghostly light. If you spell out a word with a continuous piece of 30- or 32-gauge bare copper wire, connect one end to the high-voltage terminal, and sandwich it between glass, the word will light up.

One of Tesla's great dreams concerned the transmission of power without wires. He didn't quite make the idea practicable, but he came close enough to enable you to amaze your friends and amuse yourself with these stunts based on wireless power transmission. Connect a metal plate to the high-tension terminal. This power transmission plate must be well insulated from the ground. A short distance away, arrange another in-

Induction Coil Replaced by Vacuum Tubes in Cigar-Box Tesla Coil

WITH a Tesla coil built from a few familiar radio parts you can try for yourself the fascinating experiments described in this article.

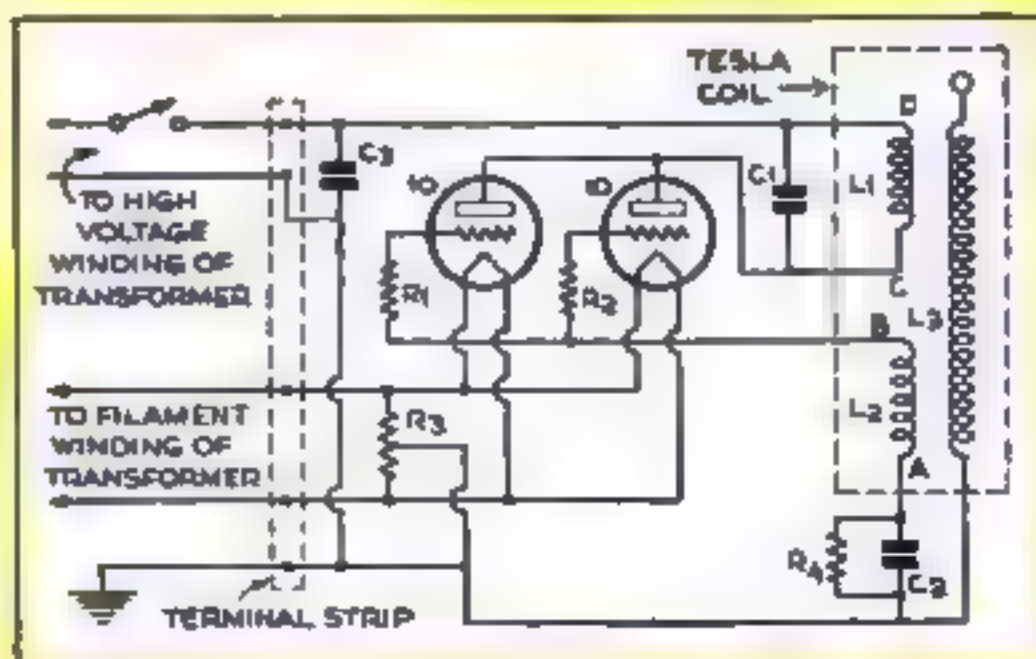
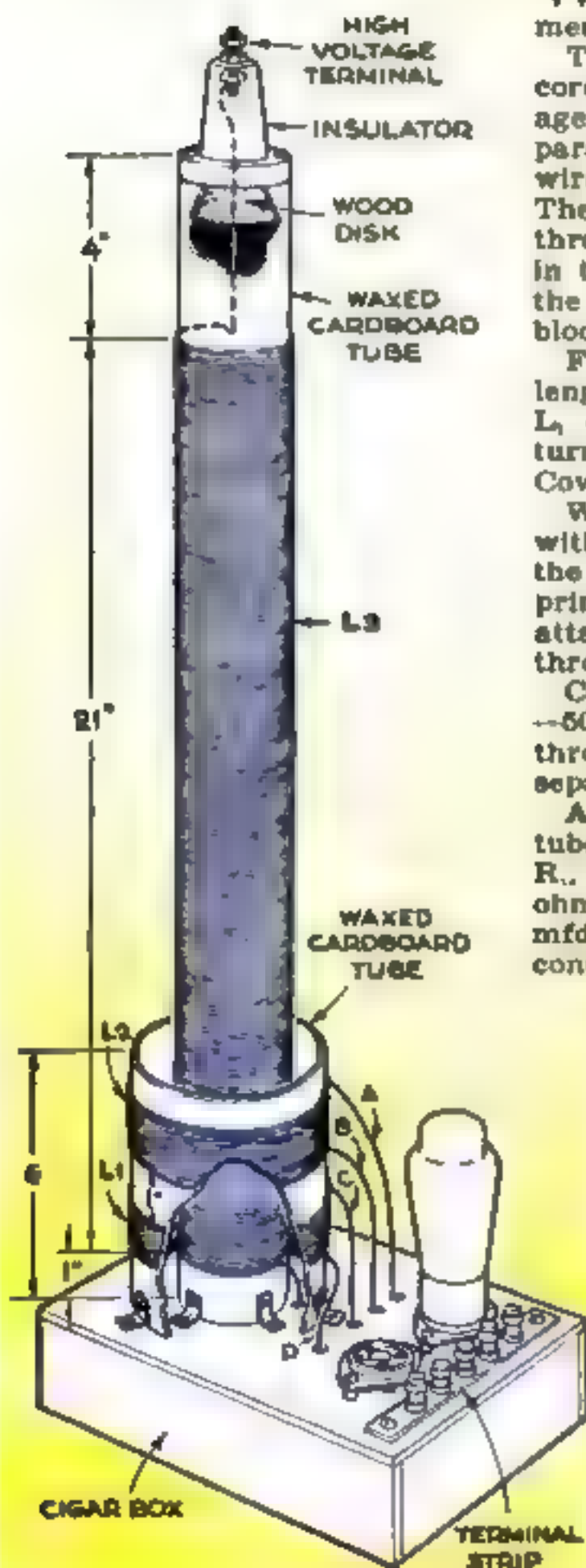
The coils are wound on ordinary cardboard tubes. A core $2\frac{1}{2}$ " in diameter by 26" long is used for the high-voltage secondary. Coat the outside of the tube with hot paraffin, and, when dry, wind a 21" coil of 30-gauge D.C.C. wire evenly and smoothly, starting 1" from the bottom. The end of this wire is brought up inside the tube through a wood block and insulator. Drill a $\frac{1}{8}$ " hole in the round block, boil it in paraffin, and glue it into the top of the tube. Screw the insulator directly to the block.

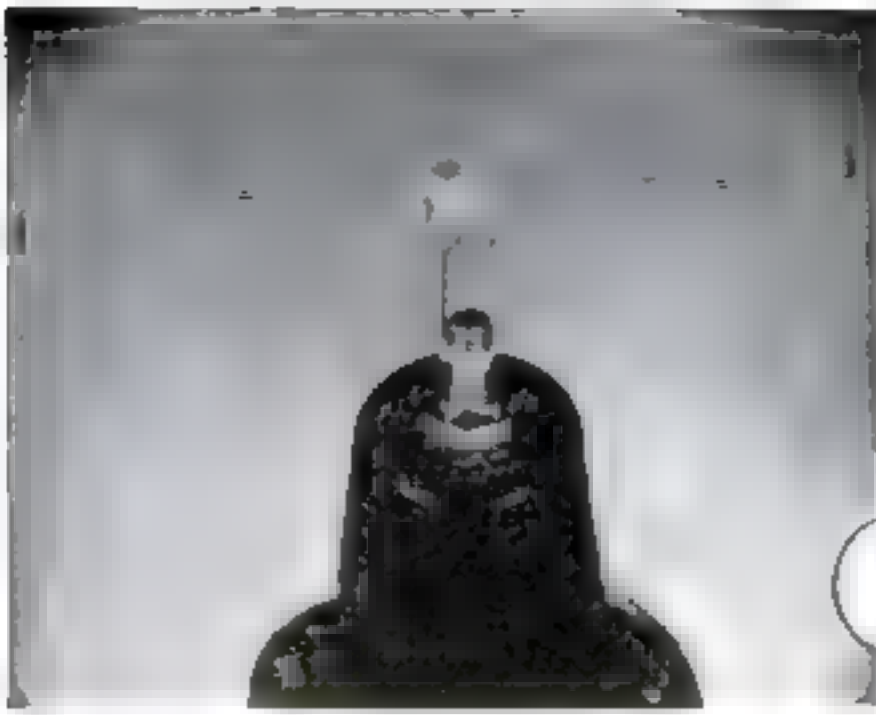
For the other coils, cut an oatmeal box down to 6" in length and use 16-gauge D.C.C. wire for both windings. L_1 can start 1" from the bottom and extend for 15 turns. Leave another 1" space and wind 20 turns for L_2 . Cover all the coils with a good shellac.

When dry, attach the secondary coil to the cigar box with small metal brackets. Bring the ground lead inside the box, making sure that it does not come near the primary. Then slip the larger form over the other and attach it in the same way. Carry the leads into the box through four small holes and fill the holes with shellac.

Connect the high-voltage side of a power transformer—500 volts or more—to the input of the Tesla coil through a single-pole, single-throw switch, and use a separate switch for the filament leads.

A pair of four-prong sockets is needed for the type-10 tubes; other parts shown in the wiring diagram are: R_1 , R_2 : 2,700 ohms, 10-watt wire-wound resistors; R_3 : 40 ohms, centertapped; R_4 : 5,000 ohms, 10 watt; C_1 : .001 mfd., 1,000-volt mica; C_2 , C_3 : .0005 mfd., 1,000-volt mica condensers.



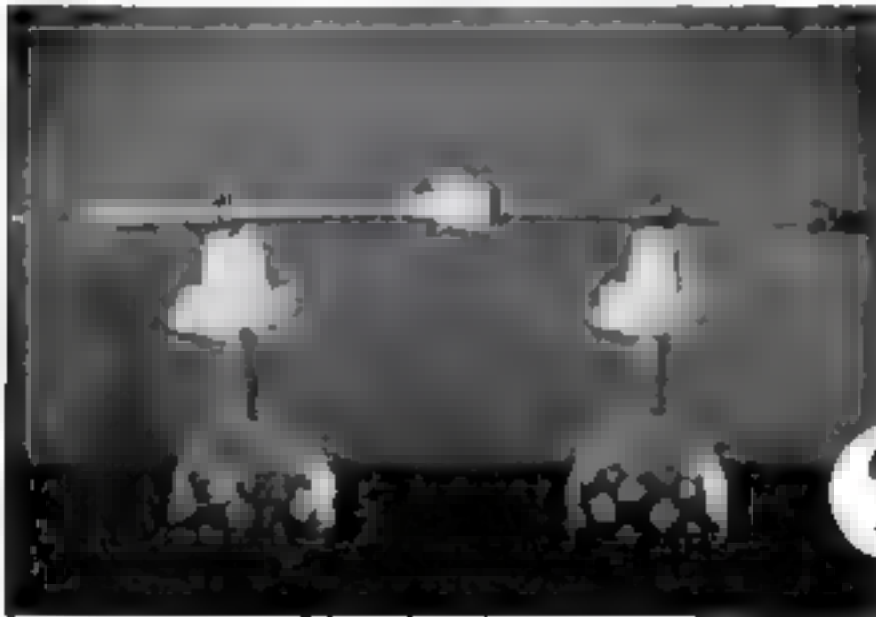


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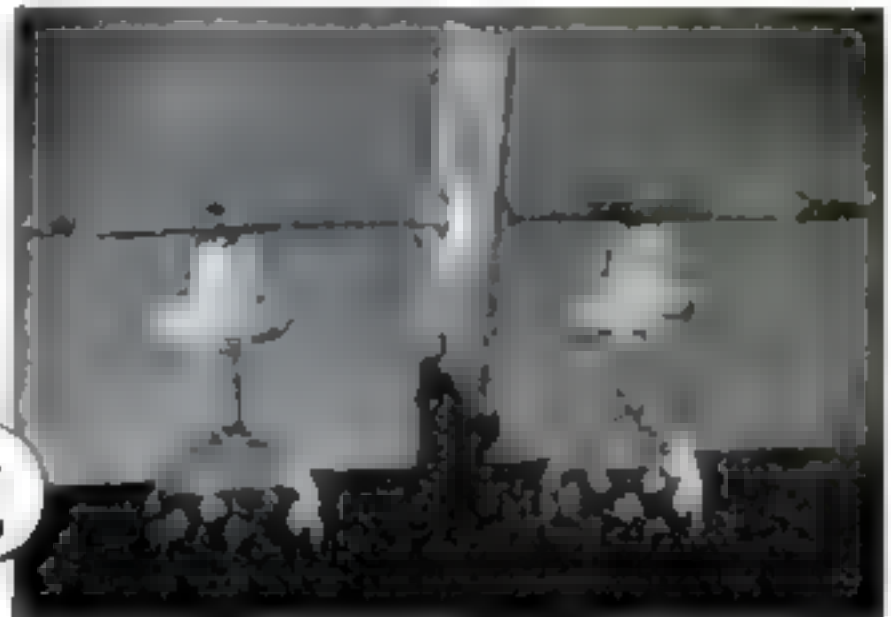


The spinner used in this experiment can be made of any light wire. Drill a small hole so that the metal will pivot on a pin attached to the high-voltage terminal. Shellac all but the tips of the horizontal wire.

If you've always had high respect for glass as an insulator, make the test shown below. The spark seems to jump the gap despite the $\frac{1}{4}$ " glass plate. You may have to shorten the gap a bit after inserting the glass.



2



insulated plate so that its face is parallel with that of the first. If you touch this power-receiving plate with a screwdriver, you will draw sparks from it even though it has no wired connection with any source of electrical energy. At still greater distances—say 8' to 10'—you should be able to light a neon tube by bringing it close to the receiving plate. Small nails scattered on the table between the two plates will also throw sparks at your screwdriver.

Now for the public part of your demonstration. Place the Tesla coil in one room and locate the power-transmitting plate close to a wall that connects with another room. Draw a chair up to the adjoining wall in the second room—preferably darkened—and begin to read a book. Do you need light? Easiest thing in the world! Just pick up a 20- or 30-watt fluorescent tube. As long as you keep your hand on the tube, it will stay lit. This works well as far as 12'. Perhaps it even presages the day when we will carry our lamps from room to room without wires.

Are you tempted to do just that with

your homemade Tesla coil? Well, don't! In the first place the system would prove relatively inefficient. Even more important, it will reduce your neighbors to a state of frenzied hair pulling. This is a point well worth bearing in mind when conducting your experiments. All high-voltage devices generate some static, causing interference with radio and other electrical equipment in the vicinity. Out of consideration for your neighbors, you should avoid using your Tesla coil at those hours when you know that most people are listening to their radios.

Clearly, a good deal of electrical energy is popping out of your Tesla coil. As you might expect, it packs a lot of heat. Hold the end of a cigar or cigarette close to the output tap, and it will readily light up. If you pass the cigarette through the corona, a large number of tiny holes will appear in the paper. An alcohol-soaked cloth will also burst into flames on being brought into contact with the corona.

Fine metal wire, such as steel wool, provides a fine fireworks display. Arrange a



The stiff wire shown at the right carries the high voltage from the coil output to a wad of steel wool spread out on the loop. Can the steel wool take it? See above.

stiff wire structure, as shown at right, so one end will make contact with the terminal and the rest is well insulated from ground. Spread some steel wool across the wire loop and close the Tesla-coil switch. The steel wool will carry the current for a moment only—then it becomes white hot and disintegrates. That's a picture of what's left of the stuff right above.





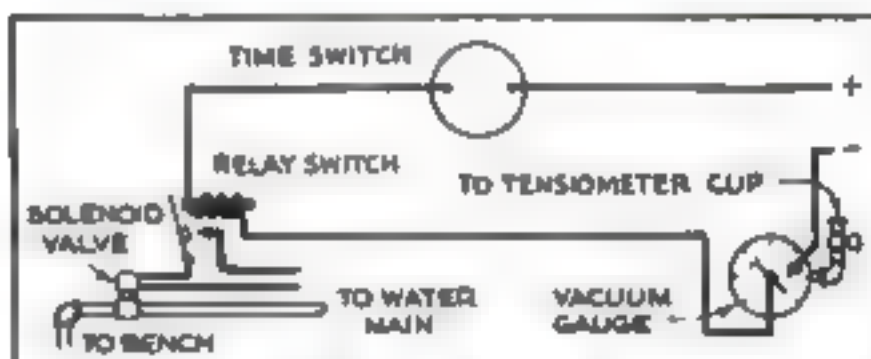
For Easier Farming

PLANE PARTS FEED BIRDS in the rig at left. A droppable fuel tank, now surplus, was modified by George H. Smith, of Sauquoit, N. Y., into a dry-mash chicken feeder of 140-lb. capacity. Below, the plastic tank is shown cut into three parts. The smallest section, which serves as a spreader, was inverted in a metal bushel basket set on legs. The middle part was suspended to hold the feed, and the larger end is a cover



AUTOMATIC BENCH WATERING. With a soil tensiometer and vacuum gauge to measure moisture content, the Cornell University agricultural experiment station makes watering of plants completely automatic. As shown in the diagram at right, the gauge is connected to a relay switch that operates a solenoid valve in the water line. A time switch closes the circuit at two-hour intervals, leaving it closed long enough to inject the proper amount of water.

When moisture content drops, the hand on the vacuum gauge moves upward, eventually touching a wire on the face. When the time switch next energizes the circuit, the relay turns on the water, leaving it on until the time switch breaks the circuit. Meanwhile water moves through the soil by capillary action, causing the hand on the vacuum gauge to drop back. "On" periods of the time switch cause watering only when the vacuum-gauge hand also closes the circuit. Thus the watering cycle is instituted by demand from the tensiometer, but limited by the time switch to compensate for lag in water dispersal.



FENCE POSTS LAST LONGER when chemical preservatives are introduced into their sap streams, according to a bulletin of the United States Department of Agriculture. Freshly cut saplings are propped for about six hours in a tub or trough of chromated zinc chloride, zinc chloride, or copper sulphate. Tests show that chromated zinc chloride, though more expensive, has more protective value and corrodes staples less.

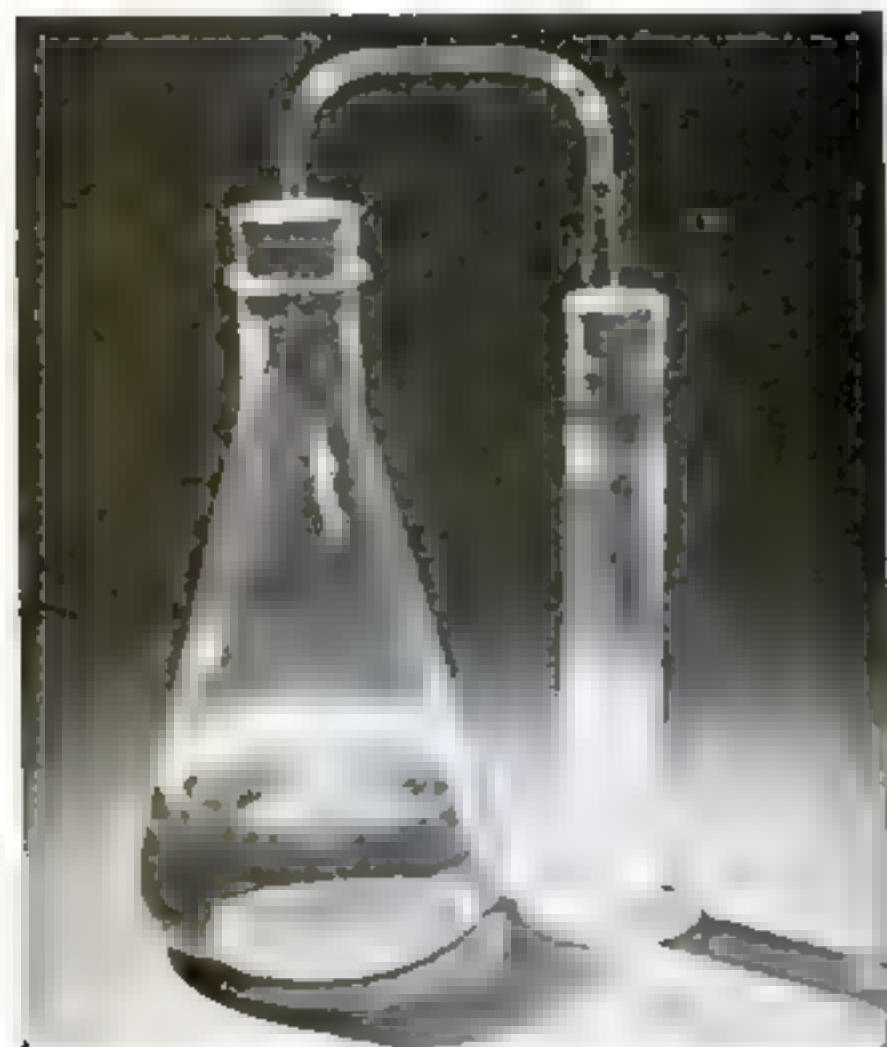


Lab distilling apparatus—distilling flask at left, condenser in center, and collecting flask at right.

ALCOHOL ... HANDY MAN OF CHEMISTRY AND INDUSTRY

These Experiments Show Chemical Traits of a Useful Liquid

By KENNETH M. SWEZEY



TO A CHEMIST, the word alcohol indicates a great family of organic compounds. Such combinations already have been made by the hundreds, and thousands more are theoretically possible. Methanol (wood alcohol), ethanol (grain alcohol), isopropanol (rubbing alcohol), and glycerol (glycerine) are a few of the common ones. An "ol" ending on a chemical name generally means alcohol.

Ethyl alcohol—grain alcohol, spirits of wine, or just plain alcohol—is by far the most prominent child of this family. In beverages and medicines made from fermented fruits it dates to the beginnings of history. Still used for both those purposes, ethyl alcohol today also is one of the most

Fermentation, first step in the most common method of making alcohol, can be demonstrated with this set up. For distillation, the second step, use the laboratory apparatus pictured at the top of page.

important industrial chemicals. During 1944, some 640,000,000 gallons—four times the previous peak production of the country—were used in making war supplies.

Industrial alcohol is *denatured* ethyl alcohol—alcohol which has been made unfit for beverage purposes by addition of poisonous substances or substances with a disagreeable taste or odor. Such alcohol is sold tax free for use as a fuel, a solvent, an anti-freeze, or in one of thousands of special industrial applications.

Like all the alcohols, ethyl alcohol (C_2H_5OH) is a substance containing carbon and hydrogen with an oxygen-hydrogen group. Take the gas ethane (C_2H_6), knock off an atom of hydrogen, replace it with an OH combination, and presto! you have conjured up C_2H_5OH —ethyl alcohol.

On paper this change is simple. But not so in actual practice. Thus far, chemists have had to use roundabout methods to accomplish the transformation. The age-old process of fermentation still is the most common method. Yeast is added to a dilute solution of a simple sugar, the yeast plants produce an *enzyme*, and the latter acts as a catalyst to change the sugar into alcohol and carbon dioxide.

You can easily demonstrate this important process in your home laboratory on a small scale. Corn syrup (glucose, $C_6H_{12}O_6$) is a good simple sugar for the experiment. Pour 25 ml. of this syrup into 250 ml. of water in a flask; then add to this a quarter of a yeast cake which has first been worked into a cream with water. Provide the flask with a one-hole stopper and a delivery tube leading from it to the bottom of a small bottle or glass cylinder. Pour some lime water into the cylinder and

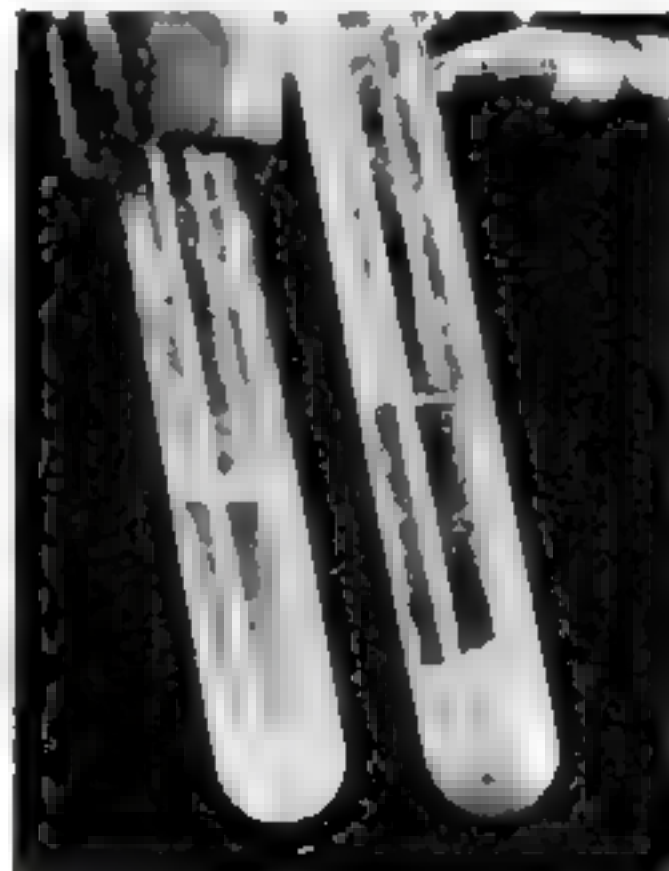
Distillation yields alcohol of not more than 95 percent concentration, but slurring with calcium oxide removes the remaining water. Right, anhydrous copper sulphate turns blue if any water remains in alcohol.



Blow into a reagent made of 5 ml. of concentrated nitric acid, 95 ml. of glacial acetic acid, and a drop of potassium chromate solution. If you have been drinking, the yellow solution will turn blue.

cork it with a two-hole stopper, leaving one of the holes open to permit escape of gas.

Let this apparatus stand in a warm place for two or three days. At the end of 24 hours, fermentation will be proceeding vigorously—froth appearing on the top of the solution and bubbles coming up through the lime water. That the gas being given off is





Mix denatured alcohol with calcium acetate solution and they will turn quickly into a solid substance. This solid is one form of canned fuel.



Place a little canned fuel on a can cover or bottle top, then light it. It will burn steadily as long as any alcohol remains.



Reaction of alcohol and an organic acid produces an ester, often used as a flavor. Addition of a little sulphuric acid speeds the reaction.

carbon dioxide is indicated by the fact that the lime water has turned milky white. The chemical reaction is this: $C_6H_{12}O_6$ plus yeast gives $2C_2H_5OH$ plus $2CO_2$.

Fermentation cannot increase the percentage of alcohol indefinitely, however. When the alcohol reaches 12 to 16 percent, fermentation stops. Further concentration is accomplished by distillation. Since alcohol boils at 78 deg. C. and water at 100 deg. C., the first vapor is rich in alcohol.

Home distillation of alcohol on a large scale is dangerous and unlawful, and any such attempt is to be discouraged. However, the small-scale distillation described in the next few paragraphs is legitimate and safe, and provides an excellent introduction to an important laboratory operation. Later, you can distill water this way.

Arrange the apparatus as shown in the photo at the top of page 198. Through a one-hole stopper in the neck of the 500-ml. distilling flask insert a thermometer so the bulb is just slightly below the opening of the side arm. A condenser can be made from two glass tubes, one about 1" in diameter and 12" long and a longer one $\frac{1}{4}$ " in diameter. Pass the small tube through holes centered in stoppers fitted to the ends of the large tube, then make an additional hole in each stopper and in each place a small tube for the water outlet. If the lower connection is used as the inlet and the upper as the outlet, the water jacket will always be full.

Put only about 125 ml. of your fermented sugar solution into the flask. Add a few

marble chips to the solution to prevent violent boiling and use an asbestos-coated screen under the flask. In the distillation of alcohol or other inflammable substances, *make sure that the stopper of the flask and all connections between flask and condenser are tight.* A flask over the lower end of the condenser will catch the distillate.

Now turn on the water through the condenser and light a flame under the flask. Watch the thermometer carefully. When vapor begins to rise and condense, the thermometer probably will read a little above 78 deg. C. This vapor is chiefly alcohol. Keep the flame as low as possible.

There are several tests to prove that your product is ethyl alcohol. Add about 5 ml. of iodine solution (made by dissolving 2 grams of iodine crystals and 6 grams of potassium iodide in 100 ml. of water) to 5 ml. of the distillate; then add sodium hydroxide solution until the brown color just disappears. Heat gently and set aside for a few minutes. A fine yellow precipitate with a pungent odor forms. This is iodoform (CHI_3). Although acetone and a number of other compounds can be converted into iodoform by this procedure, in this particular case—where there is no possibility of the presence of these other compounds—the proof is for ethyl alcohol.

Another and more spectacular check can be obtained with a reagent made by mixing 5 ml. of concentrated nitric acid with 95 ml. of glacial acetic acid and adding one drop of a solution of potassium chromate (1 part chromate dissolved in 9 parts of

water). Add to this solution a few drops of your distillate and warm it slightly. If ethyl alcohol is present, the yellow solution will turn blue. This reagent also can be used as a breath test for intoxication.

Even with the finest distilling apparatus, 100 per cent pure, or absolute, alcohol cannot be made directly by distillation. The purest contains 4 or 5 percent water. One method of removing this water is to mix the 95 percent alcohol with calcium oxide, and redistill it. The water then unites with the calcium oxide. For test purposes you can simply mix some 95 percent alcohol with some lime (calcium oxide). Stopper the flask and let it stand several days. The clear liquid above the settled lime is nearly absolute alcohol.

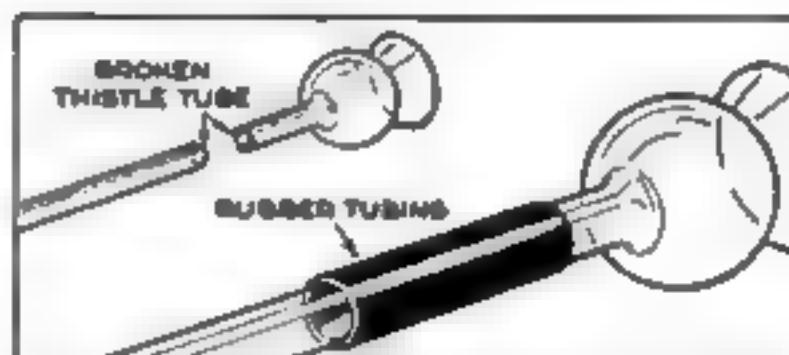
Anhydrous copper sulphate can be used

to determine whether water remains. Shake a little with some alcohol in a test tube; then let it stand half an hour. If any water is present, the sulphate will turn blue.

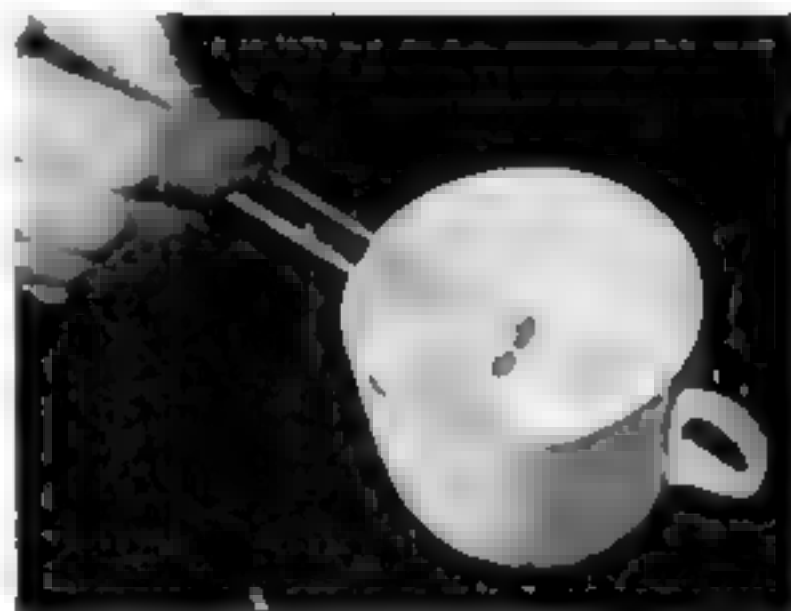
A common jellylike canned fuel is a form of alcohol solidified by a chemical change. This can be made by pouring 9 parts of denatured alcohol into 1 part of a saturated solution of calcium acetate and stirring.

Many artificial fruit and flower flavors are esters—compounds resulting from the reaction of alcohol with an organic acid. Ethyl acetate, a common ester, can be made by adding a mixture of 5 ml. of glacial acetic acid and 2 ml. of concentrated sulphuric acid to 5 ml. of ethyl alcohol. Heat by placing in hot water, then let it stand. In a few minutes the fruity odor of ethyl acetate will become evident.

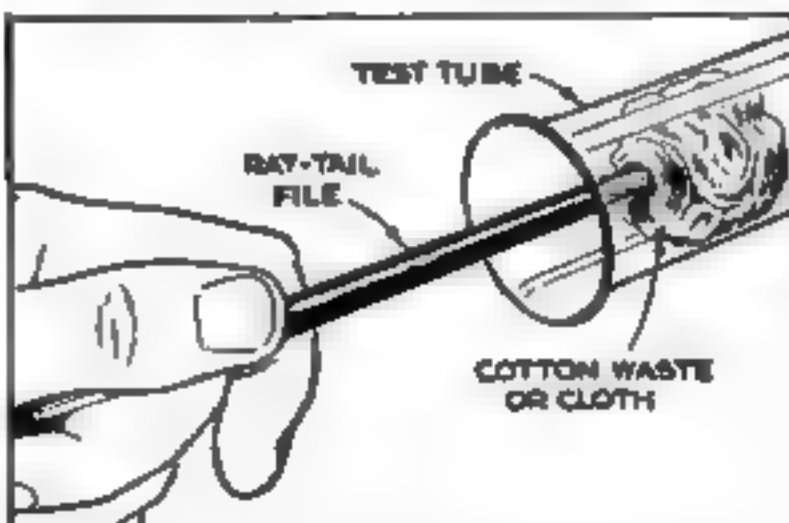
BROKEN THISTLE TUBES can be repaired by joining the sections with a piece of tight rubber tubing. For additional strength the rubber can be wound with thread and coated with nail polish. This method is especially useful when it is impossible to heat and fuse the pieces together.—MICHAEL F. MEIER.



COMPOUNDING chemicals in the home laboratory frequently calls for the use of a mortar and pestle. A coffee cup and a piece of glass towel rod, used as shown at the right, will provide a satisfactory substitute. It will be well, however, to mark the cup with a skull and crossbones so that henceforth it never will be used accidentally for its original purpose, for the traces of chemicals that remain might prove injurious. In addition, if you are using a glass rod that has been broken, the broken end should be smoothed or taped.—HERMAN KLEIN.



CLEANING glass or metal tubes, or even bottles, can be accomplished with ease by use of a rattail file and cloth or cotton waste. Push the cloth into the tube with the file. When the file is rotated it readily catches and rotates the cloth, cleaning the inside of the tube thoroughly. When the file is withdrawn, the cloth comes right along with it. I have found this idea particularly useful in cleaning out test tubes, far more efficient than other means.—RICHARD C. HARE.





YOU CAN'T

HOME EXPERIMENTS WITH

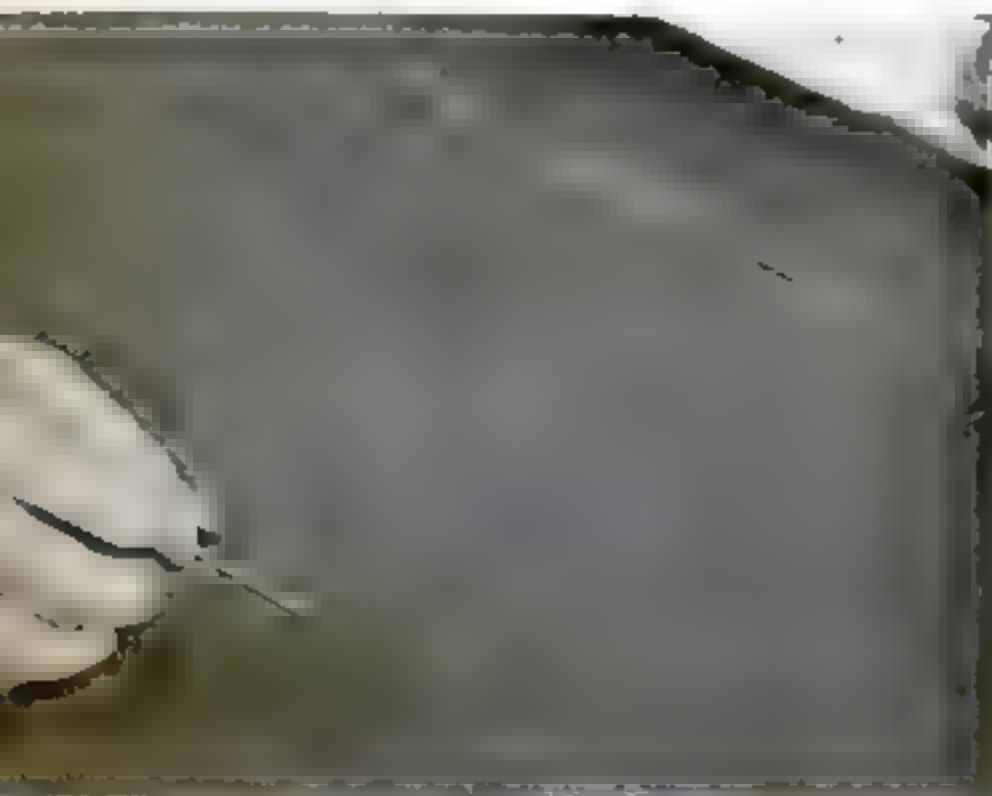


TASTE AND SMELL frequently play us false. Grandmother knew exactly what she was doing in holding her children's noses while they swallowed the castor oil, and science now recognizes the fact that the taste of many things is attributable largely to their smell. For example, if a pear is held close to the nose while an apple is being eaten, the apple will seem to taste like a pear.

TOUCH a marble with crossed fingers as above, close your eyes—and confusion begins. Although you know there's only one marble at your fingertips, your senses try desperately to convince you there are two. This illusion, which incidentally was noted by Aristotle, results because in everyday experience pressure on the outer sides of adjoining fingers indicates two objects.

SIGHT often may be unreliable because of optical illusions. Arrange three toothpicks in a line as below. Then ask someone to place a fourth so it forms part of the opposite side of an imaginary square. A ruler will show that most persons misjudge it by a good deal. The usual error is to underestimate the distance and drop the toothpick too close.

SOUND sometimes gets mixed up with the sense of touch, as this experiment will show. Rub your fingers lightly over the back of a friend's coat while vigorously brushing your own—and your friend will give you sincere thanks for brushing him off! The feel of your fingers combined with the sound of the brush conveys to the friend the perfect illusion that he's the one getting the brush-off.



TRUST YOUR SENSES!

SENSORY PERCEPTION SHOW WE MAY OFTEN BE FOOLED



TOUCH SENSITIVITY varies on different parts of the body's surface because nerve endings are distributed in varying concentration. On the fingertips the nerve endings are closely packed, and on the lips and tongue they are still more concentrated. But on parts of the body where great sensitivity is not needed, the nerves are comparatively scattered. If you thrust two pins through a

strip of heavy cardboard about 1" apart and touch a blindfolded person on the arm, as at the left, he will say that the point of only one pin touched him. But move the pins close together as at the right and touch his fingertip and he will note immediately that there are two. On some parts of the body, the thigh for instance, pin pricks as much as 2" apart may be interpreted as one.

HOT OR COLD? What we think we feel often is governed by what we see. For instance, without the help of our eyes we may not know whether an object is hot or cold. If you are not convinced, touch a piece of ice to the back of someone's neck while in a group of smokers. The victim's angry expostulations that he was burned with a cigarette should be sufficient proof.

SOUND DIRECTION usually can be determined because the ear nearest the source receives a louder impression. But when sound reaches both ears with equal intensity from a point above, in front, or behind, the directional sense is poor. A blindfold test will show this. Snap your fingers above, in front, or back of the blindfolded person. Often he won't know the right direction.





Mark Is Painted on Saw Table to Align Work Accurately

SIGHTING along a mark on the work rarely produces accurate cutting on the circular saw, especially when the work is marked on an edge as above. But a line painted on the table, in front of and aligned with the saw blade, will show exactly where the kerf will come. It is equally useful in cutting to length, forming tenons or end rabbets, and sawing outside dado lines.

First make sure the table is properly aligned, with the grooves parallel to the blade. Then, with the blade well above the table, hold a straightedge against one side and scribe a line along the table, being careful not to bend the saw blade out of true. Repeat on the other side of the blade. Fill the space between the lines with any durable paint light enough to show plainly.

Ideally the painted line should be the exact width of the saw kerf, so for laying it out mount the blade you most commonly use.—H. W.

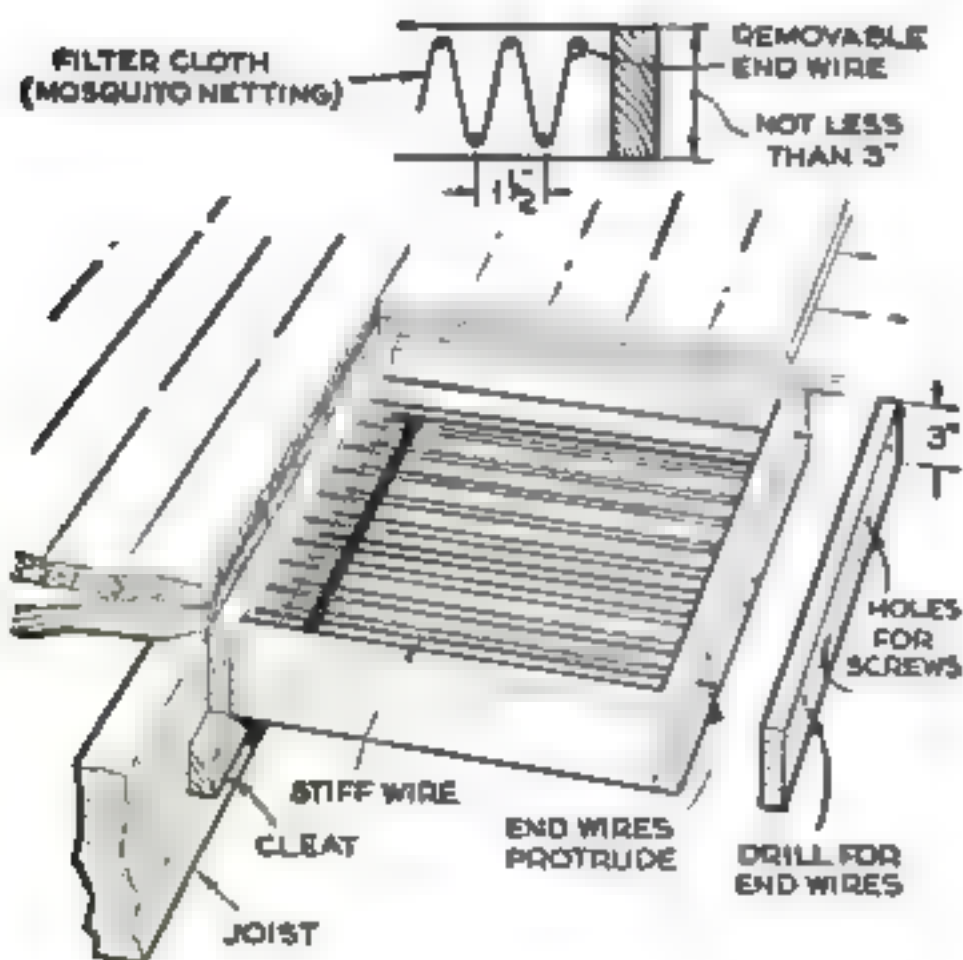
Bud Vase Made from Light Bulb

PLAIN and frosted incandescent bulbs make dainty vases for a bud or two. Large vases can be made from 200-watt bulbs. Remove the screw end and with pliers break off the thin glass stem in the center. No jagged edge will show. Cement the bulb in a glass caster cup.—BEATRICE E. REESE.



Welding Removes Broken Stud

TO DRILL out a stud broken off beneath the surface of a workpiece is troublesome, and it may necessitate rethreading the hole. With a large-diameter stud broken not far from the surface, you can sometimes add weld metal to the top of the stud, and then, after a head has been welded to the extension, unscrew the stud with a wrench.



Filter Under Warm-Air Grille Helps to Keep House Clean

WITH a little scrap lumber, some stiff wire, and a piece of mosquito netting, you can make an effective filter for a warm-air heating register. When you remove and clean it every three or four weeks you will see how much dirt it holds back.

Cut the wire into lengths equal to the distance between joists minus the thickness of the detachable frame member. The two end wires are a little longer.

Rip the netting or an old lace curtain to suitable width and hem the ends to thread the end wires through. Then rinse out the starch and moisten with light oil, possibly cedar oil for a pleasant smell. Loop the netting over and under the other wires as in the top drawing.—GEORGE I. SMITH.

Long Stair Stringer Is Strongly Spliced with Lap Joint

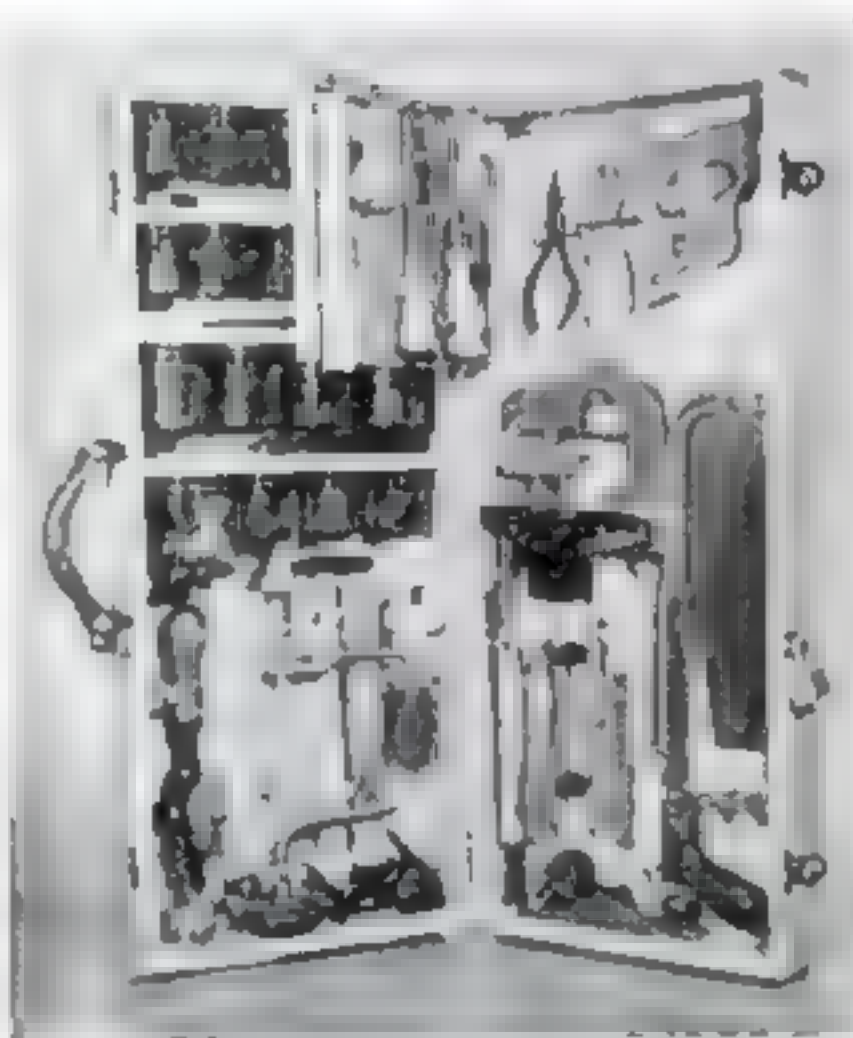
IF YOU find it necessary to splice a housed stair stringer because of a lumber shortage, you can do a strong, neat job by lap-jointing the pieces on a line with one of the tread grooves, as shown at right. Where the customary stringer thickness of $\frac{3}{4}$ " and groove depth of $\frac{3}{4}$ " are employed, the thickness of the face wing (the undercut end of the piece at the bottom of the photo) must be slightly greater than the thickness of the back wing (on the other piece) to avoid cutting away the bottom of the riser groove in the face wing. Also do not cut out the tread groove at the edge of the back wing until the pieces have been joined, for the groove material is needed as a stop against which the face wing can be butted. Join with glue and wood screws.—J. MODROCH.



Chest Affords Storage Space for Tools in Apartment

HOLDING sufficient tools to take care of routine household jobs, this chest was born of the necessity for compact storage in a cramped apartment. It measures 6" by 12" by 30", may be stowed in a small closet, and when stood on end can be slid easily from place to place on its gliders. Tools are placed so that the weight is balanced, and the closed case may be carried with comfort. All tools and supplies are easily removed and replaced.

Clips bought at a hardware store, short lengths of screen-door spring, and wood turn buttons are used to hold the tools. A small swinging panel increases the tool-mounting area. Nails, screws, and other small parts are kept in small glass jars, the metal screw-on tops being fastened under a line of shelves. A grip and fasteners for the case came from an old suitcase.—R. B. LEWIS.



California Stud Requires Only Three Members at Corner

BUILDERS who like to save time and material can do both with the idea illustrated here. I don't know where it gets the name but some carpenters call it the California stud. It uses three two-by-fours instead of four, providing a saving in material of one complete length. When the three two-by-fours are nailed together, plenty of space is available for nailing, the inner laths in the corner.—FRANCIS B. JACKMAN.

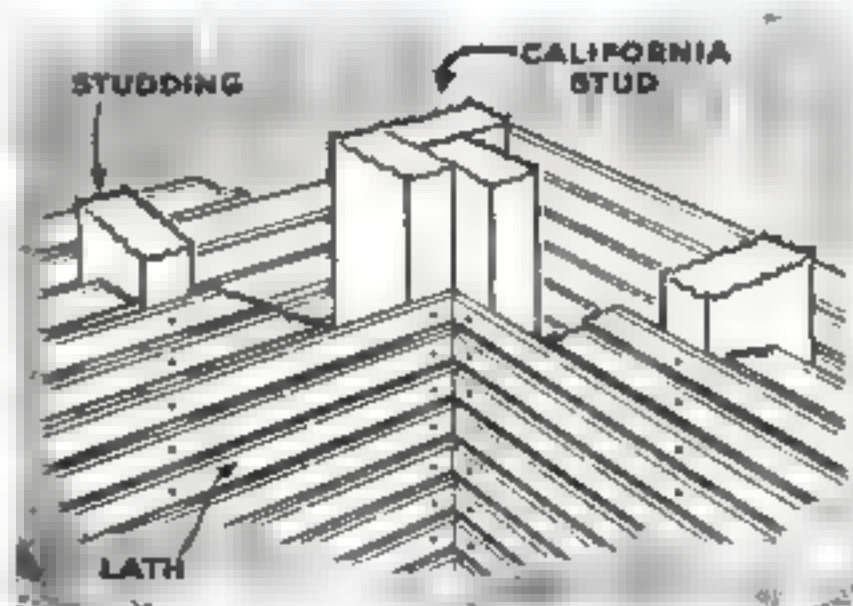




TABLE TRICKS

1 TOSSING DICE into a glass is hardly a trick. But hold two dice and the glass in one hand, as shown above, and try getting the dice in one at a time. The first die can be caught readily; but when you try throwing the second up, the movement pops the first out of the glass. Instead drop the second, and move the glass under it.

2 GRAVITY CAN BE DEFIED if you have the know-how! Close your left hand around a pencil; then grip your wrist with your right, as shown, pretending that this exerts magnetic action. Slowly open the fingers from around the pencil and then the thumb. But be sure to hold the pencil with your unseen right index finger!

3 MATCHBOX MAGIC. With the drawer on the far side of a tunnel formed from the box, challenge anyone to make the drawer come through the tunnel toward him—without touching anything. When others have given up, cup your hand behind the drawer and blow smartly into your palm. The drawer will be blown toward you.

4 RIGHT OUT OF THE HAT come cards at your command. Let the deck be shuffled and cut. Place half in a hat, cover with another hat, and shake to mix them. Then let



a friend slip three cards from the remaining half between the hats face down. Shake the hats again. You can then pick his three cards unerringly. Bend your half deck before putting it in the hat. The chosen cards, being flat, are then easily distinguished.

5 NUMBERS ON A CARD are a real puzzler. While your back is turned have someone cover for a minute or longer one number on a card like that below. Then hold the card to your forehead while you pretend to concentrate, but take a surreptitious look at it in the darkness of your cupped palms. If luminous paint was used, the number that was covered will glow less than the others, enabling you to name it.



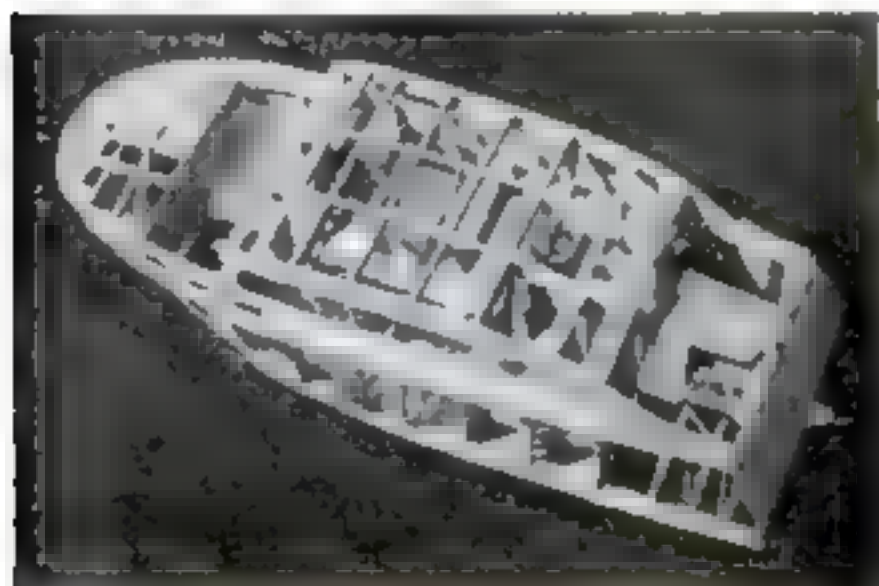


A Modelmaker Builds His Dream Boat

PREVENTED during the war from building the special 30' cabin cruiser that he planned, Louis J. Seigmann, of Newark, N. J., decided to do the next best thing. He built a carefully detailed model of his dream boat, scaled at 1" to 1', that incorporated the features he wished in the full-size craft. The construction of the model parallels that of a regular boat, except that the decks and cabin are removable so that the interior can be inspected. Even the galley is fully equipped with tiny dishes and miniature cooking utensils.

Now that materials are about to become available, Seigmann plans to construct the full-size *Shangri-La*, profiting by his experience with the small prototype to build a cruiser that meets all of his desires.

Meticulous detail is apparent in the scale model. The engine installation is in the after cockpit.



Seigmann adds the final touch to a part. Cabin and decks are removable for access to the inside.

All flags fly on the completed 1" to 1' model as they will on the 30' *Shangri-La* that will follow.



Vertical Railroad

(Continued from page 124)

Medical research has shown that it's not speed that produces queasiness, but the rate of acceleration or deceleration. The only physiological restriction on speed is the fact that, for the average person, descents of more than 600 feet, at a speed of 1,500 feet per minute, are liable to be uncomfortable because of the rapid change in atmospheric pressure.

The past of our hard-working little indoor railroads is almost as fascinating as their present and future. Somebody, believed to have been Chinese, had the simple but extremely useful notion long ago that by wrapping some rope around a drum and twisting the drum with a lever he could raise water from a well with less effort. In one sense, this lazy fellow made the Empire State Building possible, because a bucket in a well and a car that can whisk you up 80 stories differ mainly in operating refinements.

Egyptian engineers devised windlass derricks to save wear on slaves employed on such public-works projects as pyramids. In one of Nero's palaces, there are indications of three vertical shaftways, and they can't all have been laundry chutes. In the seventeenth century a Flying Chair, in which a passenger moved himself by hauling on a rope as in a dumb-waiter, was used at the French court until "a serious mishap occurred to the King's daughter, as a result of which the Flying Chair fell into disfavor."

Hand-powered freight lifts appeared in England and America in the nineteenth century. In its more refined form, a man-powered freight elevator consisted of a platform running between vertical rails and attached by ropes to a drum above. Counterweights balanced the platform and average load. Geared to the drum was a large pulley from which an endless loop of rope dropped down the shaft past the platform. If a man hauled on this rope, he could lift a ton or so of freight without heart dilation.

Steam engines were added to these rudimentary elevators in the 1850's, and the Astor House installed a passenger lift that must have dazzled New Yorkers. A steam engine was connected to the hoisting drum by two belts, one rigged in the conventional manner and the other crossed into a figure eight. The second belt was used to give reverse motion, powering the elevator in either direction. Levers moved by a rope permitted the operator to select either belt. This elevator occasionally reached a speed of 50 feet per minute, or .57 m.p.h., a fair

approximation of a hands-and-knees pace.

One visionary produced a machine whose specifications called for a giant screw to run vertically through the building, with a car acting as a nut on the screw. Another seer replaced the counterweight on his elevator with a huge water tank that could be filled or dumped at will. The "water-bucket elevator" was capable of high speed—practically a free fall—but never became popular.

If the car of an early steam elevator was overloaded at an upper floor, the extra weight might force the engine backward, pumping air into the boiler and depositing the passengers abruptly at the bottom. Gearing that permitted no unpowered motion stopped this tendency. Soon the engine was directly connected to the hoisting mechanism, which ended the jerky uncertainty of belts, with directional control provided by reversing the engine.

By the seventies steam elevators were smooth and fairly efficient. Some ran 500 feet a minute, a fair speed today, and skilled operators were needed to make accurate, gentle landings. But steam found a relentless competitor in hydraulic elevators.

These were amazingly simple in theory. Water pressure moved a piston in a cylinder and the piston moved the car. Sometimes the cylinder was placed on its side in the basement and connected by a block-and-tackle rig to the counterbalanced car, and in other installations the cylinder was vertical. A variant design, known as the plunger-lift elevator, put the cylinder directly under the car, like the greasing lift in your gasoline station. This required a hole as far beneath the basement as the highest story extended above. On very high rises the plunger had a regrettable tendency toward buckling if it were not made almost prohibitively heavy. Occasionally, too, hydraulic elevators would coast upward beyond pressure when a stop was made after a fast rise, the plunger overtraveling and dropping back on the water with a jolt sufficient to show the whites of a passenger's eyes.

Progressively higher operating pressures became necessary in the race with steam, 700 pounds per square inch wasn't uncommon. As a result, maintenance men were forever struggling with leaking glands and hissing joints. One handbook of the period mentions an effort to use the discharged water in the building's sanitation system, but sudden variations in pressure made this

difficult. Probably the favorite whim of errant hydraulic elevators was known to the trade as "creeping." Instead of standing still, a car having this trait would wander off along the shaft unless watched closely.

Electric power was used in 1884, but did not become a real competitor for several years. It was more efficient because no stand-by power was required. Nearly all the passenger elevators built nowadays are electric.

A better hoisting principle was developed about the beginning of this century that was well suited to tall buildings. Under the old system the height of travel was limited by the drum diameter and by the width of the drum that could project into the hoistway. The "traction system," introduced in 1903, replaced the drum with a sheave, or multiple-groove pulley, mounted on the shaft of a slow-speed motor. Hoisting cables now run over the sheave and a secondary sheave, and then run off to the counterweight, thus leaving only a small, constant amount of

cable at the top. One feature of the system is that if for any reason the motor should fail to stop, either the car or the counterweight will rest at the bottom of the shaft, releasing tension from the cables and allowing the sheave to rotate harmlessly. With a drum, the same mishap might pull the car or counterweight into the overhead beams, jerk out the cables, and drop the load.

A limit to the height of buildings, more restrictive than the strength of steel, is the number of elevators that can be installed and still leave an economically efficient building. An office-building architect may be confronted by the probability that 35 percent of the building's population will arrive within 20 minutes in the morning and depart within 15 minutes in the evening. Traffic men are likely to consider the morning peak a more difficult problem because congestion occurs in the lobby rather than on scattered floors. Presumably, it is better to have impatient people spread over the building instead of massed in the lobby.

Collision at Sea

tion and avoidance of collisions. He had an idea. He talked it over with his junior officers. They liked it. It was this: Set up a school using synthetic training. Simulate with realism all the equipment used in conning a ship. Reproduce actual sounds. Study past collisions and, from the causes, evolve a uniform emergency shiphandling procedure so standardized that skippers of any two ships would know in advance what maneuver the other was most likely to execute. Simulate collision situations and train officers to think in split seconds, but in terms of comfortable safety margins.

Back in port at Pearl Harbor, Lott sold the idea, and he was named Officer-in-Charge. Ten days later he opened his first classroom.

"It was pretty crude," he recalls. "All equipment was handmade of stuff we pulled off scrap heaps, and there wasn't much equipment even at that. What we didn't have, we invented. But our student officers were patient. We passed out questionnaires soliciting criticism, and got plenty. As a result, the course, as it stands now, is the work of thousands of officers."

There isn't a single lecture in the curriculum. "Fast-moving as a Broadway show, and almost as interesting" was Lott's goal. The course quickly gained an overwhelming acceptance. Even officers on short shore leave after months at sea gave up priceless hours to attend. Six months after the first class, collision rates in the Pacific

(Continued from page 129)

began to drop. At the war's end, collisions had been virtually eliminated. Lott was installing new schools on the mainland for postwar use.

How was it done? The magic was the realism with which Lott imbued the course. *The secret was making young officers realize that they had to reckon with the speed and course of the other ship, as well as of their own.*

For instance, one ship is steaming north, another ship southeast, both making 15 knots. When these ships are still 1,850 yards (more than a mile) apart, their courses will intersect and they will collide in just two minutes—120 seconds—if some action is not taken. Their relative speed (the combined speed at which they are closing on each other), called range rate by the Navy, is high, much higher than many inexperienced officers would realize. **AND** the time left to act is short!

Another example: One ship is heading due east, another due north, both making 34 knots. When they are 1,655 yards apart, just 60 seconds are left before the crash. However, at the 1,655-yard range, if the eastbound ship executes a left turn, it will miss the other ship by 750 yards; if it turns right, it will miss by 550 yards.

The curriculum at the Emergency Shiphandling Schools established 500 yards as the minimum safety margin to be considered for small vessels, and 1,000 yards for large. This Lott and his colleagues

pounded, drilled, and hammered into the student officers' heads. These same heads were buzzing after the intensive course, which winds up with these final exams:

An entire day is spent in making simulated runs. First, daytime runs are simulated; then night runs, during which the "ships" are followed by their lights. Then come the difficult poor-visibility runs, in which radar must be used almost exclusively.

In all of these runs, actual collision cases are reproduced and the conning officers of the two ships are thrown into sudden and imminent "danger" by the instructor, who manipulates the shiphandling gear to reproduce the error that was made in the original collision. This might have been a TBS (Talk-Between-Ships) radio failure, causing one ship to fail to receive a turn signal; a junior officer turning the wrong way in formation, with the captain lacking time to get up to the bridge in time to avoid the collision; or a rudder casualty suddenly throwing two ships onto a collision course.

During these runs, every situation and condition is simulated with great realism. The conning officers are on their "bridges," booth-like enclosures from which they cannot see the junior officers of the deck. These JOODs, equipped with all the aids they have on shipboard, sight on model ships, and relay bearings and ranges to the conning officers on the ships' intercommunication system. They must physically carry out every action. If the captain should be called, the student must actually press the button, and the buzzer sounds. This auditory realism is carried to the point of dropping a pile of scrap iron on a steel floor in the next room at the instant of a collision.

On the "bridge" the captain has his steersman, ship's telegraph (by which orders are transmitted to the engine room), radio, radar scope, and ship's intercom. He "cons" through binoculars that are reversed to create the illusion of distance.

After each run, action taken by the student officers is evaluated, and mistakes are pointed out. JOs are reminded forcibly that the captain would rather lose his sleep than his ship.

Occasionally, an officer encrusted with years of sea experience dropped in at the school to snort his disbelief of the need for any kind of shiphandling procedure in an emergency. Having conned by the seat of his pants for years, he'd be damned, sir, if he needed any newfangled ideas to help him. Lott's gang had a cure for that type. Would the captain care to "con" a case? The captain couldn't very gracefully refuse. So they would give him a really tough collision case that had actually occurred—

an end-on case where both vessels were approaching at a relative speed of 60 knots, a situation in which the slightest hesitation or misstep on the part of either captain would make a collision inevitable. When the "crash" occurred, the boys in the back room would let go with the scrap iron. After one treatment, even the crustiest sea dog calmed down considerably.

One senior officer went through the course, conning his ship beautifully out of collision after collision. Afterwards, he made himself known to Lott as the skipper of one of the ships in a collision which had been recreated in the course. He said he had been sleeping when the collision occurred, and because his junior officer hadn't recognized the danger signs in time he had not been called to the bridge.

The new training has tremendous implications for peacetime merchant fleets, as well as for the Navy. Lott is planning a course which will prove that the new art is yet in its infancy.

He is drawing plans for an auditorium-size classroom where a dozen or more ships can be conned simultaneously from enclosed bridges, with results visible on a screen at the front of the room. Between the bridges and the screen will be seats for a large number of students. Behind and above the bridges will be a bank of projectors, each of which will throw on the screen the movements of one ship, as the skippers issue their orders. Inside two of the bridges, each captain will have a simulated radar scope on which he can watch the movements of all the other ships, with his ship indicated in the center. Thus, involved convoy and task-force problems can be worked out. The equipment will be electronically operated, and with it Lott hopes to simulate every conceivable situation at sea. His postwar aims are:

1—To have every prospective deck officer go through the school and pass a standard shiphandling test.

2—To have every shiphandler take a shiphandling test every four years, and to go back to school if he fails.

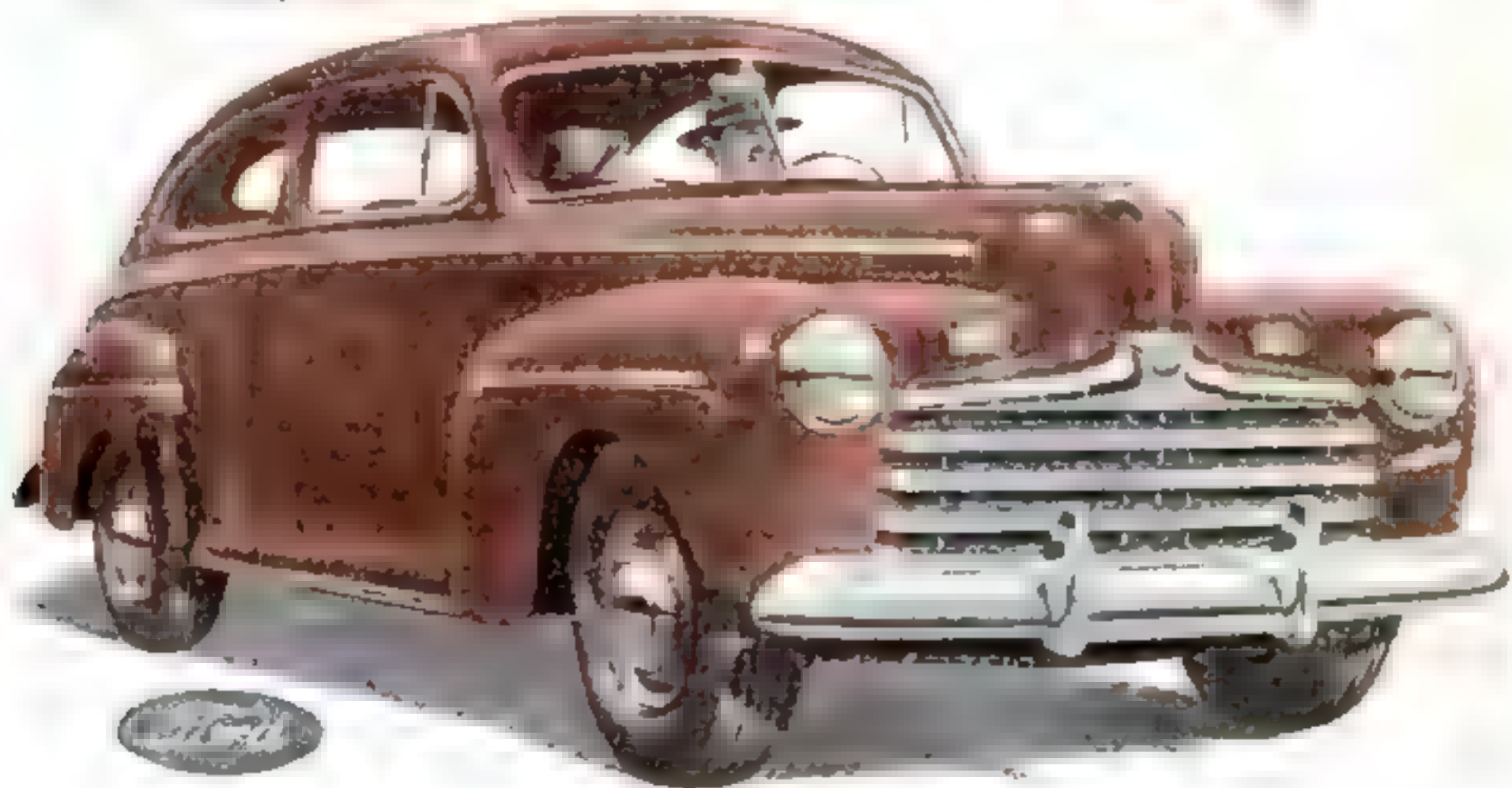
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The Rise and Fall Of a Chemical Empire

(Continued from page 69)

had even been put on 50 tanks by V-E Day.

High explosives simultaneously became so scarce that thousands of shell cases were never filled, and rock salt comprised up to 70 percent of the contents of others. Such shells boosted the morale of retreating German troops by making loud noises, but were only about 30 percent as effective as properly filled shells. Nitrogen intended for use as fertilizer was diverted to munitions, but even so there was not enough. Antiaircraft ammunition became so hard to get, according to General von Arthelm of the Flak Artillery, that battery commanders were told never to fire at an enemy airplane unless, first, they were sure it was going to attack the target they were supposed to defend and, second, they felt sure they could hit it.

"In modern war," according to no less an authority than Major General Henrici, the German Army's Chief of Ordnance, "a country's ability to produce munitions decides victory or defeat. The destruction or crippling of the munitions industry is the key to victory."

The destruction of Germany's munitions industry was a by-product of the strategic attacks on synthetic oil targets. American and British air power, in fact, caused the whole German chemical empire to collapse in the last few months of the war like the One Hoss Shay.

This was before the first atomic bomb burst. How, nowadays, can any nation protect its vital war industries from air power?

Under the direction of Franklin D'Olier, chairman of the U. S. Strategic Bombing Survey, the foremost available engineers and scientists sought the answer to this question in Germany. The Oil Division of the Survey now has reported to the Secretary of War that Germany's vital oil, chemical, rubber, and explosives industries might have been destroyed even more quickly if aiming points had been chosen more wisely, if the bombing had been more accurate, and if more powerful munitions had been used. Vigorous research along these lines, and the establishment of an adequate intelligence agency is recommended by these authorities.

Aerial and passive defenses far superior to those that Germany had would still leave American industries vulnerable, their report concludes. The best defense is the prevention of attacks.



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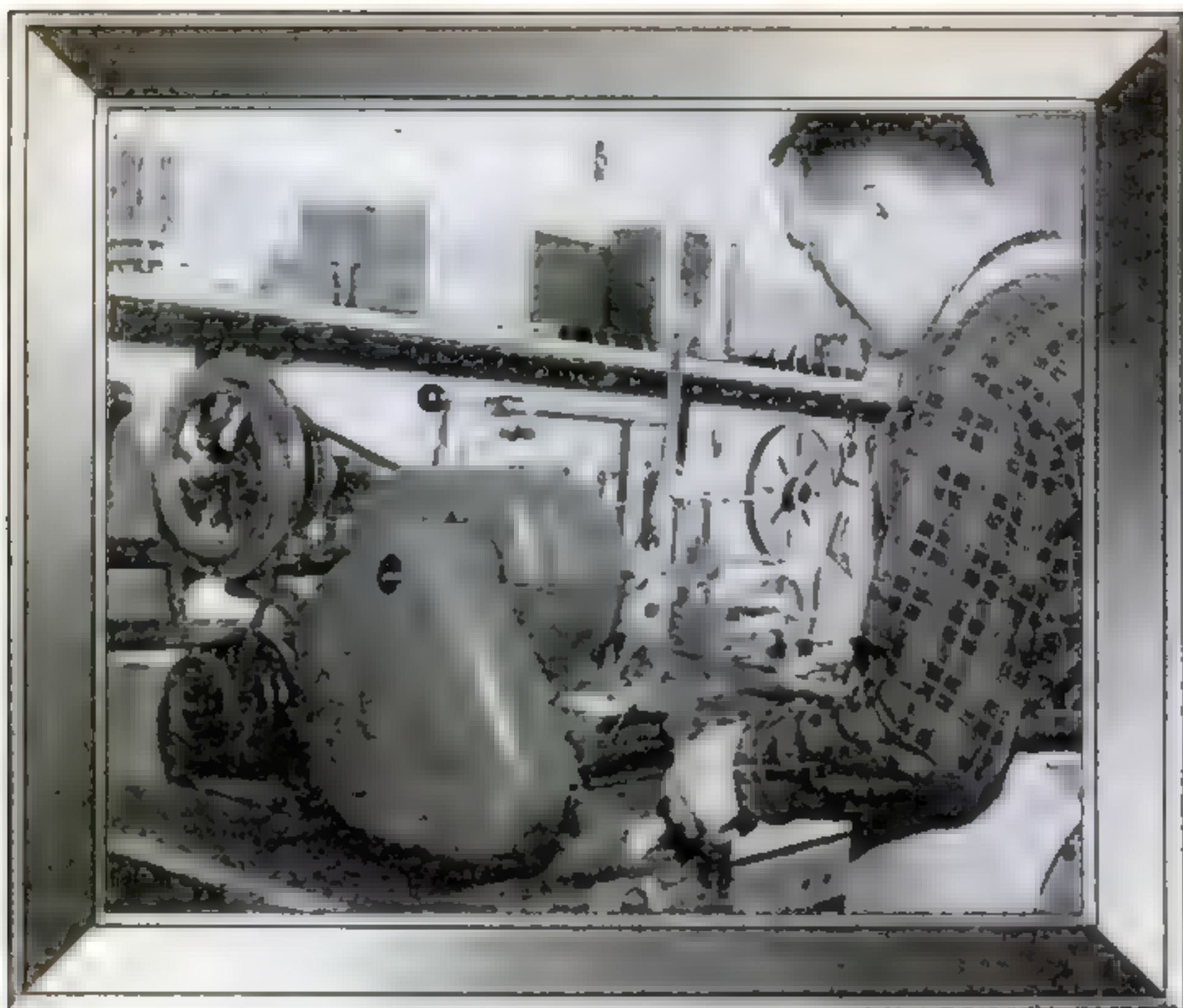
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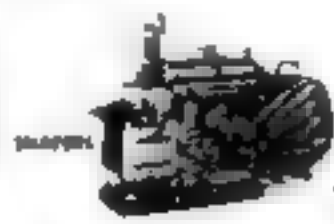
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Why Jap Air Force Died

(Continued from page 91)

called the Shusui, to be powered with a copy of the Walther used in the ME-163, the first German rocket plane.

In another development, a jet coupled with an internal combustion engine was used in a new suicide plane, the Baka 22. A four-cylinder Hataukaze, inverted in-line, air-cooled engine drove a single-stage compressor to provide the power for these specially built Kamikaze planes, of which the Japs had close to 100 assemblies in construction.

Probably their most outstanding achievement had been in the development of an axial-flow, turbo-jet engine with which they planned to power a conventional-structure interceptor called the Kikka. The first test model of the Kikka had gone in the drink in August when the pilot pulled the throttle on takeoff instead of pouring on full power. The Japs were also planning to use this engine in a new suicider designated as the Baka 43, which had reached the mock-up stage.

The pulse jet was the fourth type under development, and of this our intelligence officers had learned little when I left Japan. They knew only that the Japs had gone as far as two small test models and these had not yet been analyzed.

Besides pushing jet propulsion in their frantic, last-minute defense effort the Japs were also converting bombers into night fighters and interceptors. They were modifying all possible planes to carry inclined fixed guns which were to shoot from the most favorable position, beneath and slightly to the rear of the intended victim. Every device the designers could dream up was being used to make up for the mistakes which had put the Japs so far behind us in fighter types that virtually their whole naval fleet had been lost.

One of these mistakes was the failure to set up a good pilot-training and rotation system along the lines of our own. Japanese flying admirals, asked to explain the failure of fighter squadrons to use teamwork tactics, always gave the same answer: "bad interplane communications," and "not enough good pilots." The Japs, after they lost most of their best fliers in the battles of Midway, Coral Sea, and the eastern Solomons, never did catch up. After each battle they used to have to pull back their first-run fliers for a sort of general re-training program.

Wartime aviation in Japan worked under a continuous handicap: lack of cooperation between the Army (Continued on page 218)

Type of 6-engine Clipper Pan American World Airways will place in service in the future.



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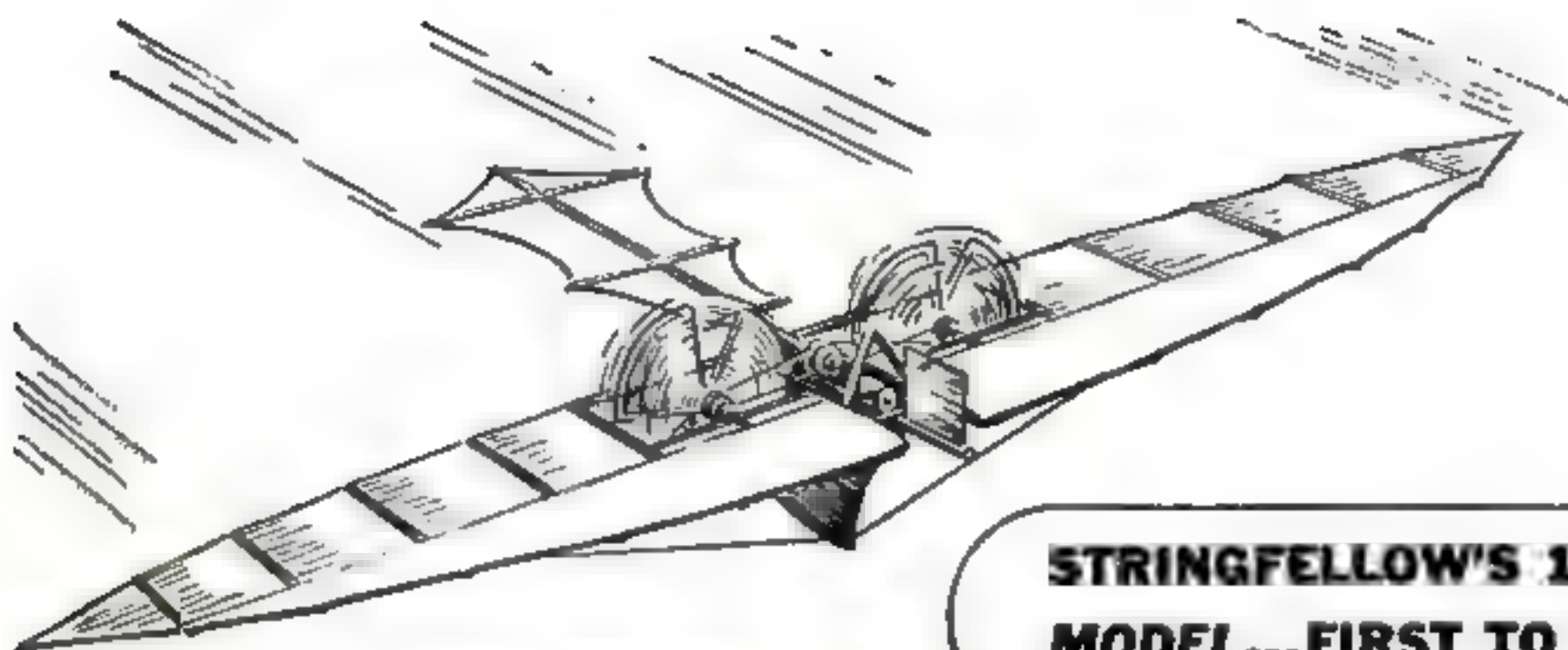
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Today, there are new horizons in spark plug performance for your present car, if you insist on dependable Champion Spark Plugs. The unequalled manufacturing facilities and experience exclusive to Champion are back of every Champion Spark Plug. That's why it will pay you to insist on Champions—the automotive spark plugs with aircraft prestige and efficiency. Champion Spark Plug Company, Toledo 1, Ohio.

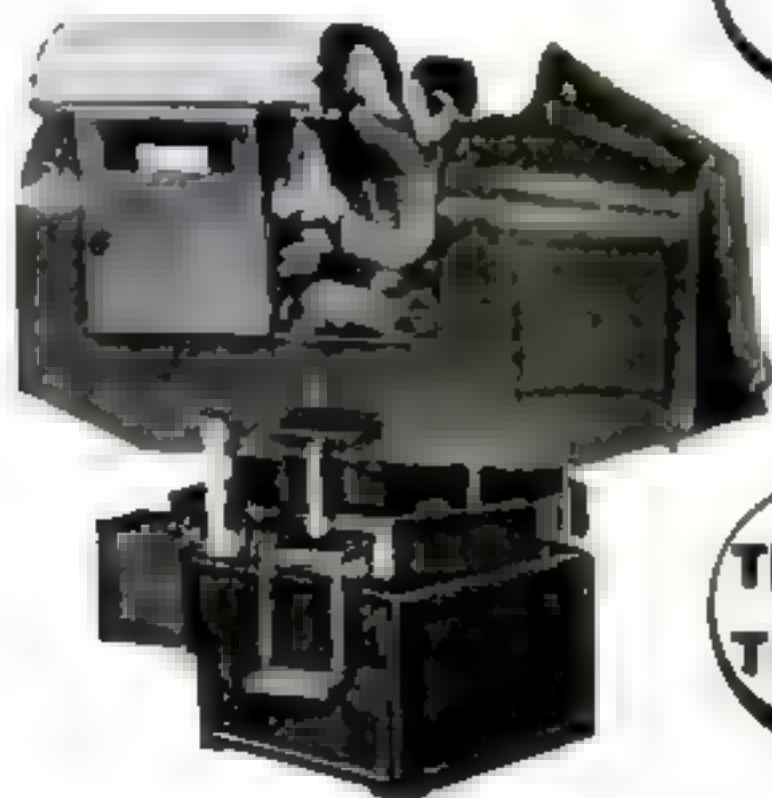
DEPENDABLE

CHAMPION SPARK PLUGS





**STRINGFELLOW'S 1846
MODEL...FIRST TO FLY**

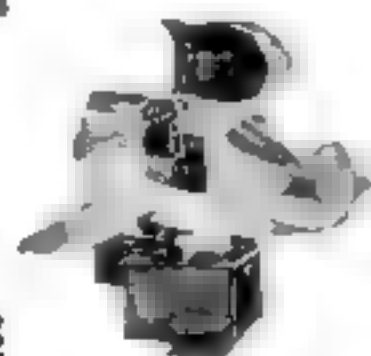


**THE LINK...FIRST MACHINE
TO SIMULATE FLIGHT**

Stringfellow proved a century ago that heavier-than-aircraft could fly. Link proved that instrument flying could be learned on the ground. Simulated flight in the Link is amazingly real. You learn how it feels to be at the live controls of a plane in the air. You see how aircraft instruments respond to speed, altitude, and air-attitude—and how they guide you through darkness and “weather.” You can make the Link glide, bank, and climb...you can practice recoveries from stalls which is a vital asset to a pilot's all around airmanship.

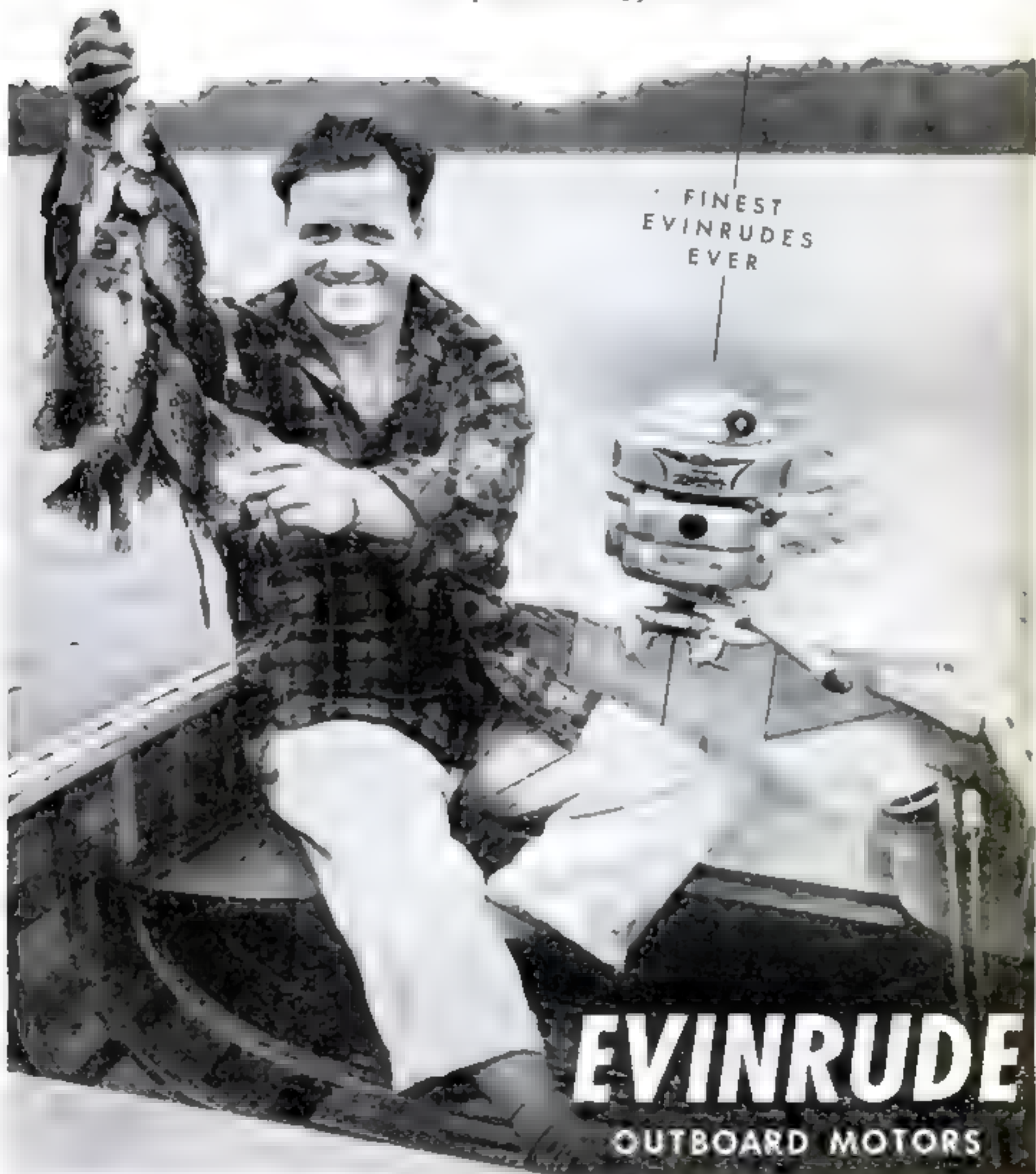
Scientifically improved over twenty years of use and experiment, the Link helped to make our flyers superior in the war skies, and has long been standard with the airlines and Air Forces. If you have the urge to fly, or if you are buying a plane of your own, training in the Link will give you greater safety, skill, and range, in the coming air age. Link Aviation Devices, Inc., Binghamton, New York. Makers of Link Trainers, Crew Navigation Trainers and other devices contributing to the safety of flight.

*Link training is your first step
into the* **FLYING AGE**



*Coming
your way -*

Steady on the course and heading right for you . . . *new Evinrudes* sparkling with the promise of more fun in '46! Again, a *complete line* of models — smart singles and twin cylinder motors — and three superb "fours"! All exactly as you would expect them . . . reflecting 37 years of priceless outboard *know how* . . . *the finest Evinrudes ever!* See your Evinrude dealer soon — and send for free catalog of the complete Evinrude line. Write for it today. EVINRUDE MOTORS, 5141 N. 27th Street, Milwaukee 9, Wisconsin.



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Utmost Reliability Again Demonstrated by
ATC Globemasters and AC Spark Plugs

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In the record-breaking time of 149 hours and 44 minutes, the Globemasters of the Air Transport Command raced 23,279 miles, to chart the world's first regularly scheduled 'round-the-world' air service, September 28 to October 4, 1945.

AC Aircraft Spark Plugs played an important part in that history-making flight, just as they did in the Constellation, Stratocruiser, and the 4 Japan-to-Washington B-29's.

Ceramic Aircraft Spark Plugs were originated and built, solely by AC, for the Liberty Engines of World War I. They were the outgrowth of AC Ceramic Spark Plugs for automotive use. These automotive plugs have been factory equipment on 2 of every 4 new cars and trucks since 1932.

AC's are everywhere chosen for *utmost reliability*. So,—especially since better gasoline and normal driving require a change in plugs,—follow this lead for greatest spark plug satisfaction.

AC SPARK PLUG DIVISION
GENERAL MOTORS CORPORATION



Aircraft Spark Plug



Automotive Spark Plug

SPARK PLUGS

HELP FIGHT INFLATION—BUY VICTORY BONDS

Why Jap Air Force Died

(Continued from page 214)

and the Navy. The two branches fought like cats and dogs. All development, purchasing, and production were carried on independently until the latter stages of the war. This resulted in duplication of equipment which a small country like Japan could ill afford when she was trying to crack the big leagues.

Poor organization also carried over into the individual services themselves. Both Army and Navy were tightly compartmented organizations where one home command knew little of what went on in the next region, much less in the field of operations. One reason was the almost pathological caution of the General Staff in matters of security, probably made necessary by its policy of keeping the facts of life from the people. But in the Jap Navy, this policy boomeranged. Officers of the rank of captain and below usually didn't get the battle news! Obviously the results were inefficiency and failure.


"I didn't know what happened in what you call the Marianas Turkey Shoot," Commander Otsuki told me. "How was I to design airplanes?"

This compartmentation policy was a direct cause of one of the gravest errors that the Japs made, the introduction of too many plane types, with which they overloaded their factories. Both Army and Navy had a way of adding new types to the point of utter confusion. One count toward the last showed something like 70 types on the books at once. For this mistaken policy, the flying officers of the Jap Navy concurred in blaming the General Staff for ordering out a new model whenever combat conditions changed.

"The trouble was that the General Staff officers were pilots but not engineers," said Admiral Tada. "They didn't know production."

And here, in the field of production, according to Soemu Toyoda, the Admiral King of the Jap Navy, was the seat of the whole trouble.

"It was a situation that we in the Japanese Navy realized even before the war," Admiral Toyoda explained. "Even then, in the United States, machinery did the work; in Japan it was men. With our dense population we did not change then for fear of unemployment. In the war we had to adopt machine production but we could not convert the nation quickly enough from its traditional hand labor. This was the basic cause for the failure of our war effort."


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Send Coupon for Free Trial Size—with easy instructions for the famous Glover's 3 Way Medicinal Treatment and FREE booklet, "The Brilliant Care of the Hair."

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Send Free Trial Application package in plain wrapper by return mail, containing Glover's Imperial Hair Dress, GLOVER Shampoo, and Glover's Mange Medicine in hermetically-sealed bottles, with informative FREE booklet. I enclose 10¢ to cover cost of packaging and postage.

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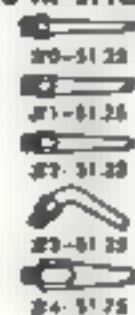
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Has Built-in
Thermostat
Control!

THERMOSTATIC SOLDERING IRON



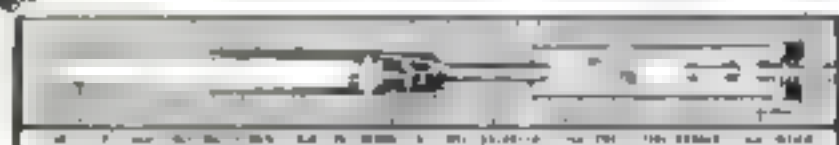
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#3-Making Pot
for Soldering—\$1.25

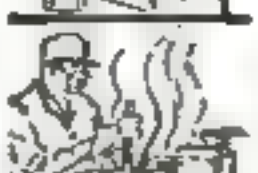
NOT READY FOR USE ONLY 34 SECONDS after plugging in. Kwikheat is the only soldering iron with a thermostat built into the tool itself* maintaining the proper level of heat for most efficient, economical operation. **SAFE!** ... Cannot overheat—**ECONOMICAL!** Lasts longer—saves tips and requires less retinning. **POWERFUL!**—225 watts—yet exceptionally light weight (14 oz.). Well-balanced with cool protecting plastic handle. Modern streamlined design. Six interchangeable tip styles adapt one Kwikheat Iron to all your soldering jobs. You will be proud to own America's finest and most versatile soldering tool... from tip to plug Kwikheat is in a class by itself. Ask your dealer to demonstrate the quick-heating feature now!

Kwikheat Iron with choice of Nos. 0, 1, 2, 3 or 4 tips \$11.00
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Dept. PS-1, Kwikheat Division of
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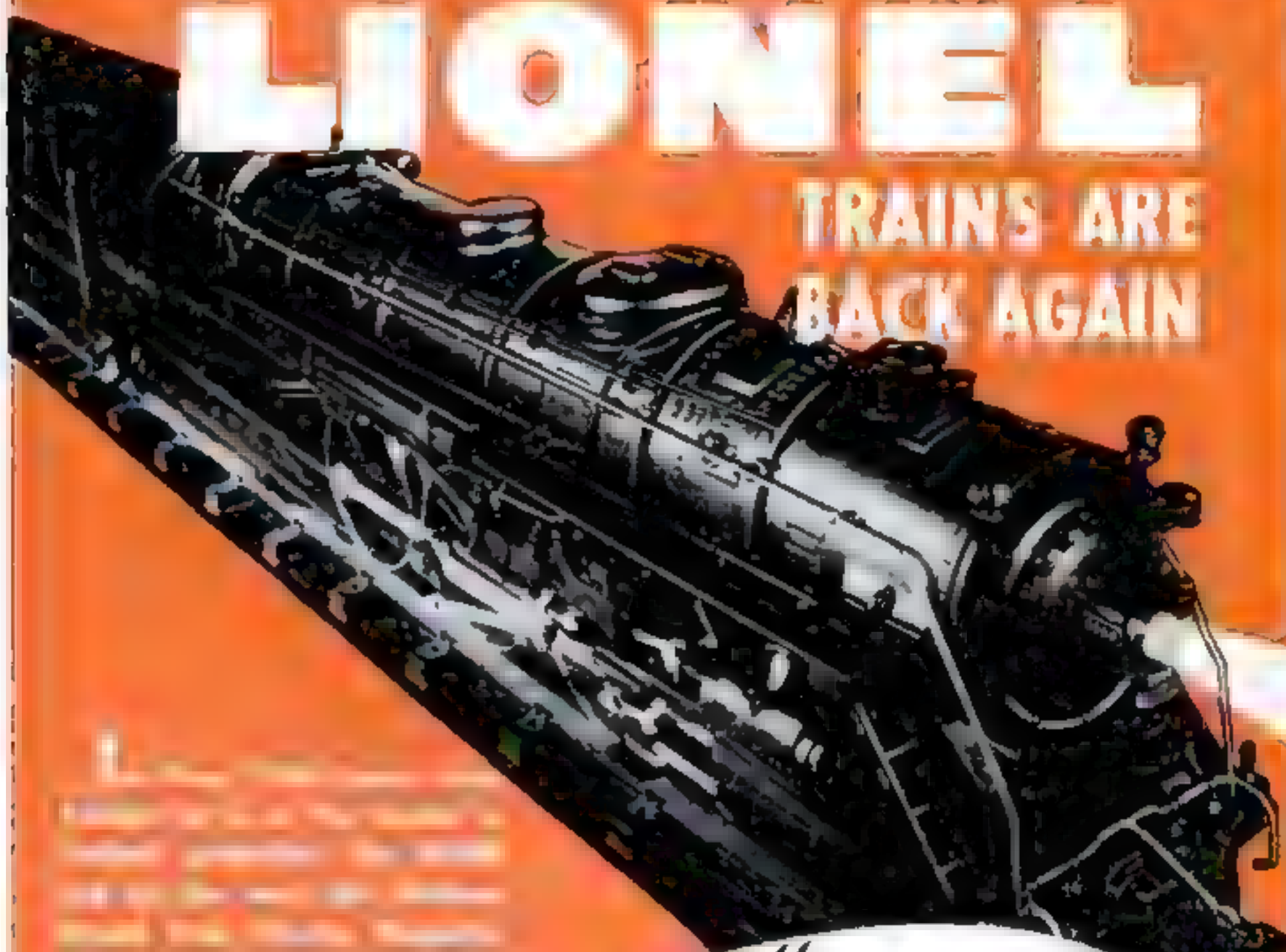
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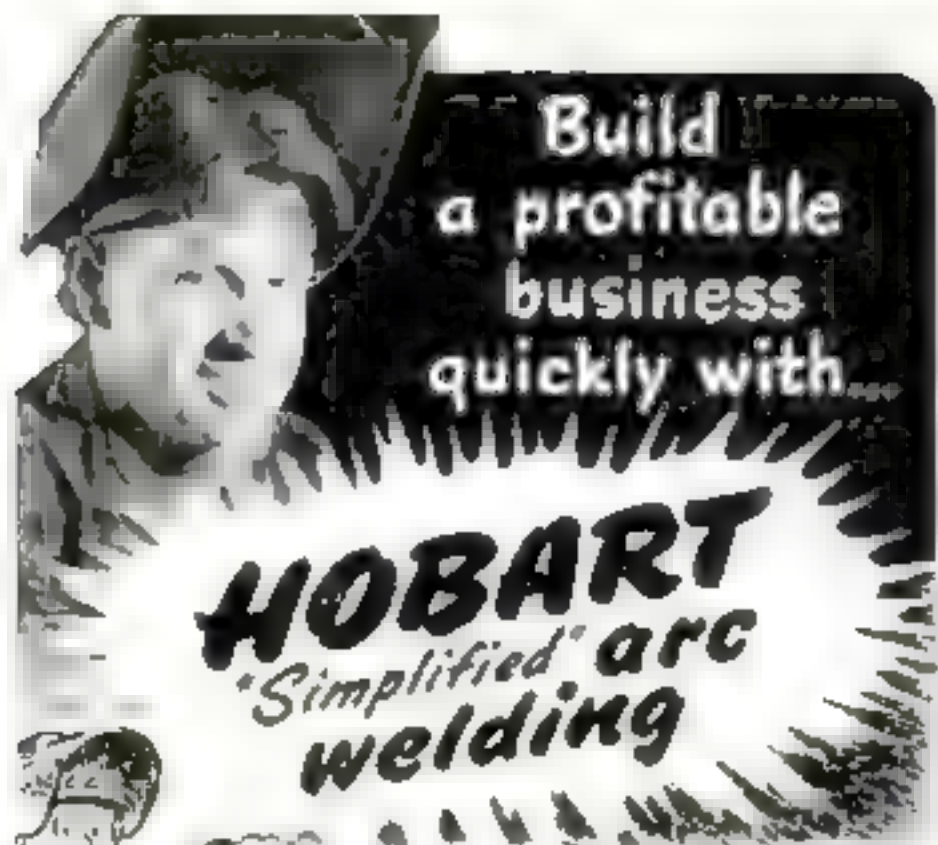


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They Bring in the Big Pay Jobs to Hobart Owners. You're equipped to do a wide variety of jobs when you have a Hobart welder—you're not limited to just a few types of work. Used by the U. S. Army and Navy. If you were in Service you'd understand why. With Hobart you'll be able to demand higher prices because it's really easy to get both speed and quality with Hobart 'Simplified' Arc Welding. Some reasons are:

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NAME _____

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Toughest Snow Shoveling

(Continued from page 96)



85 miles an hour, plows sometimes have to be used as anchors to hold parked aircraft steady against the gales. One gale in Greenland blew a Fortress clear across the base, dragging tie pins and all until the tail rested in the water. Spoiler boards are also used along the wings to kill the lift over them and prevent their being lifted off their wheels and slammed down again. It takes a right smart breeze to lift a B-17 Fortress bodily and bang it back on the concrete apron.

Some arctic gales drive the snow into giant icy drifts too high and tough for even the Sno-go's to tackle. Then the pick-and-shovel gang go to work and break it up for the trucks to haul it away. One man on each unit of equipment watches the control tower for red lights warning him of landing planes. The machines then move off the runway and stop, but as soon as the plane touches down the equipment swings back into action.

At some of the bases the snow-removal gangs have developed other techniques. At Goose Bay, Labrador, for example, the snow is sometimes rolled into a hard surface with huge snow rollers.

Farther south, quick thaws and freezes require liberal sanding of icy runways. The sand itself is a problem at some bases and at a premium at most of them, so the bases make much of their own with rock crushers. Sand (ground somewhat coarser than usual to retain the heat longer) is heated almost red hot before it is thrown on the ice-coated runways, where it sinks into the ice and freezes in before it can be blown away.

Methods perfected on the North Atlantic route can be used in Alaska, Siberia, and other frigid lands. Removing up to 500,000 square yards of snow a day, however, has cost the Government up to \$25,000 a day, or roughly \$500,000 a year, at a single base. Airline promoters are waiting to see how long the landlords are prepared to pay for the world's biggest snow-sweeping jobs.

—C. B. COLBY.



DEATH IN THE AIR. Many a Jap pilot, spinning down in flames from high over an American warship, quite literally never knew what hit him. Neither did enemy intelligence, bewildered by the accuracy of Allied gunnery.



FIVE-TUBE RADIO transmitter and receiver, in the fuse of the shell, is the brain of the secret weapon. In flight, the transmitter broadcasts a continuous radio wave. Reflected back from the target, this wave explodes the shell at exactly the right moment!

THE SHELL WITH A "RADIO BRAIN"

Army, Navy lift censorship on mystery weapon that licked V-Bomb, Kamikaze attacks



TYPICAL of "Eveready" "Mini-Max" power is this 15-volt *bearing-aid* battery. Small, light, economical, it makes possible lighter, easier-to-wear bearing aids. It is now available.

"CIGARETTE - CASE" RADIOS, small enough to wear, are made possible with this "Mini-Max" Battery. It packs 22½ volts into a package smaller than a standard box of safety matches!

NOT EVEN the Atomic Bomb was more "hush-hush" than the "Variable Time Radio Proximity Fuse"—a fuse mechanism that decides for itself when to explode; requires no advance setting.

Transmitter, receiver, and detonating mechanism all draw power from a tiny "Eveready" "Mini-Max" battery: a "powerhouse" rugged enough to withstand the shock of the gun's discharge: a force 20,000 times that of gravity!

EVEREADY

MINI-MAX

The registered trade-marks "Eveready" and "Mini-Max" Maxine products of National Carbon Company Inc.

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prevents backflow
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CONDENSING CHAMBER
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BOWL GUARD
keeps shank
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REMOVABLE SECTION
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Finesse!! THE TRICK IN FINE SHAVING!

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Sealed Power Individually Engineered Ring Sets are selected from twenty-six basic designs of piston rings. Whatever the make, model, and cylinder-wear condition of your engine, there's a Sealed Power Set specifically engineered to do the best possible job in it. Sealed Power Piston Rings have been the choice of major engine builders for 34 years, a record of which Sealed Power workers are extremely proud. For maximum power, say "Sealed Power." Sealed Power Corporation, Muskegon, Michigan and Windsor, Ontario.

KEEP YOUR WAR BONDS! GET \$4 FOR \$3!

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For better results 26 Basic Ring Designs

No one piston ring design can meet all replacement needs. Sealed Power Individually Engineered Ring Sets are made up from twenty-six (26) basic ring designs, which permit each set to be specifically engineered to do the best possible job in a particular make of engine.

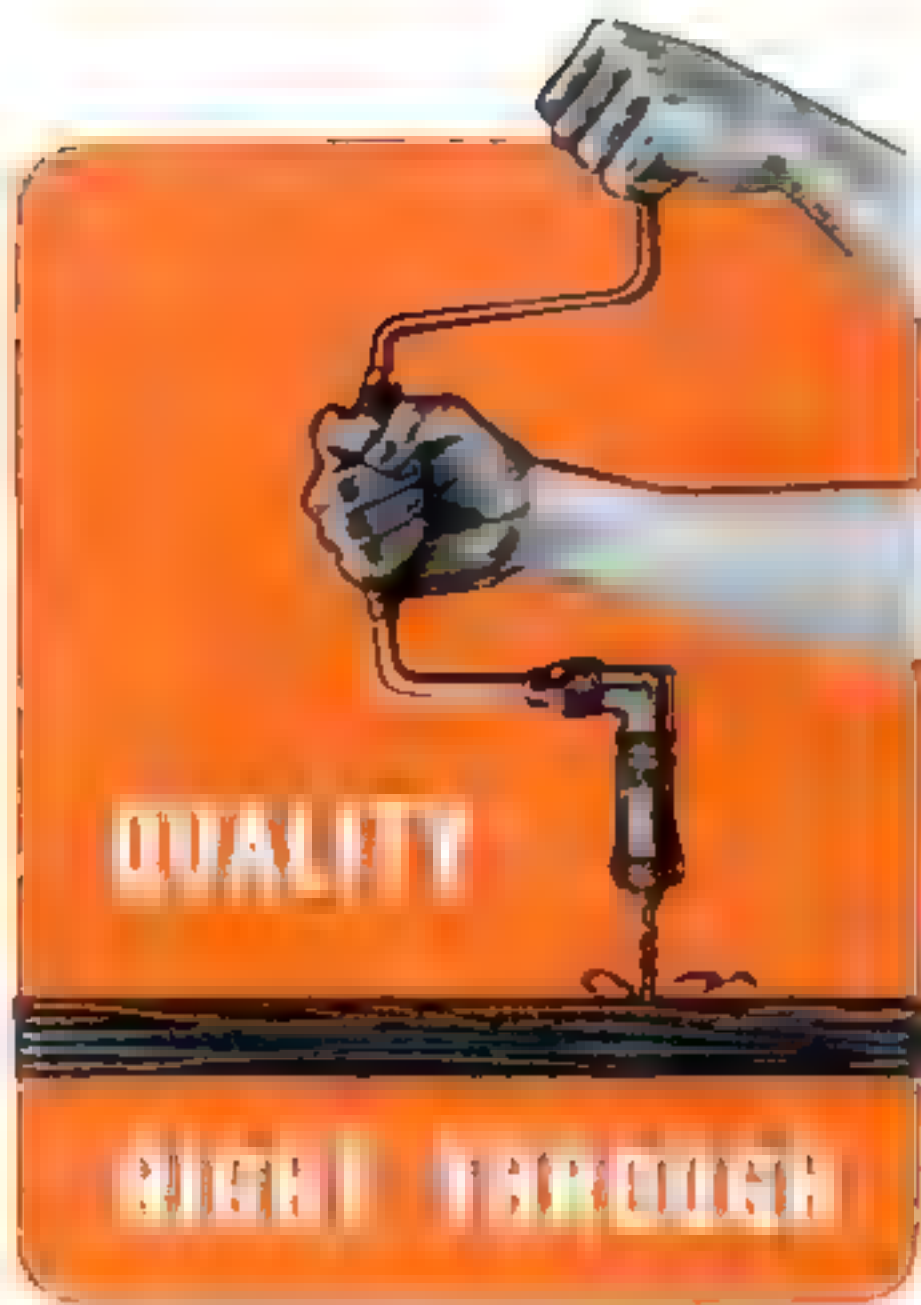
These ring sets are engineered to save gas without sacrifice of oil economy, to save oil without inducing friction and cylinder wear. Each set gives *balanced* performance in a particular engine.

Piston Rings
Pistons
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SEALED POWER PISTON RINGS

BEST IN NEW CARS! ★ BEST IN OLD CARS!



The first time you use a Miller's Falls Brace and Bit you'll know you have hold of **QUALITY** tools. You'll feel the precise balance of the brace and the dispatch with which the bit speeds cleanly through the wood, however hard.

This same quality runs right through the complete line. There are Miller's Falls hand and electric tools for a thousand and one uses. The variety is almost unlimited. But the sterling quality is the same.

See your dealer. Miller's Falls fine tools are becoming increasingly available.

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Gives power to your craft skill in embossing, tooling, carving, slicing, engraving, and a host of other craft and shop jobs where "hand work" quality is desirable.

Operates by vibration, 120 strokes per sec.; 110 V. AC, 60 cycles.

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Long before Pearl Harbor Dremel Moto-Tools had won their spurs in tool rooms, machine shops, home workshops. Now they have the respect of every branch of the armed forces. And thousands of them helped establish production records at General Electric, Westinghouse, Remington Arms, Ford, Nash-Kelvinator, Consolidated Aircraft, Douglas and others.

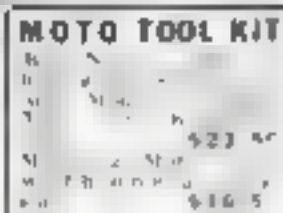
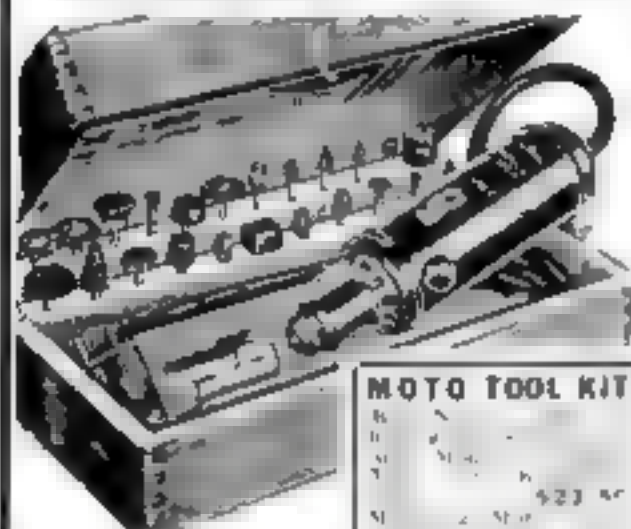
Now that priorities have been lifted, Moto-Tool can work for you. Moto-Tool owners daily discover new jobs that can be done more expertly in less time. In fact, new purchasers find dozens of uses in addition to those they had in mind. So great is the saving of time and labor with Moto-Tools, thousands of mechanics and craftsmen would find it difficult to get along without their "mighty little midgets."

ONLY MOTO-TOOLS HAVE ALL THESE FEATURES

A Model 2 Moto-Tool develops a speed of approximately 27,000 rpm. Weighs only 1.3 oz. Shaped to fit the hand. Sturdily built with shock proof bakelite housing. Balanced for vibrationless operation. Uses 110-120 AC or DC current.

10 DAY TRIAL—Money Back Guarantee

Ask your dealer today about Dremel Moto-Tools and Accessories. If he does not handle them, order direct from factory on 10-day trial. We ship postpaid if cash in full accompanies order. If you prefer to send only \$2.00, Moto-Tool will be shipped C.O.D. for balance plus postage. Catalog sent FREE.



MODEL 2 Illustrated

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WELDWOOD
PLASTIC RESIN
WATERPROOF GLUE

UNITED STATES FLYWOOD CORPORATION, New York 18, N. Y.

Fooling Enemy Radar

(Continued from page 83)

electric echo. The measurement of the round-trip time of the echo gives the distance of the detected object. A man, shouting loudly toward a cliff, hears his call echoed plainly. But if another man shouts continuously at the same time from some point among the cliffs, the first person cannot hear his own echo. This is analogous to what happens in electronic jamming.

Radars betray their existence and location by their pulsing beams. They can be heard by a "search receiver" at a greater distance than the radars can detect the plane or ship carrying this instrument. We designed airborne direction finders, with which to pin-point enemy radars, and "pulse analyzers," which told us the pulse width, echo periods, and frequencies of German and Jap equipment. Musical tones revealed whether the sets were high- or low-frequency types, and our own radar countermeasures experts could deduce accurately the purpose of these sets.

The AAF and Navy planes that carried this special equipment were known as "ferrets" because they ferreted out troublesome enemy radars. Ferrets were also equipped with window and rope, and other jammers called "carpet" and "rug." They operated offensively as well as defensively by jamming radars to screen the approach of our bomber and warship formations. Wider application of window and jamming sets by regular bombers cut down our losses to enemy antiaircraft and night fighters to a surprising degree.

The enemy, however, adopted certain countermeasures to thwart the far superior Allied radar. Then Army, Navy, and civilian RCM people found means to counter the countermeasures. We reproduced German and Jap radars, had our own planes apply countermeasures, and worked out defenses against American jammers and window to see how the enemy would try to do the same thing.

This electronic warfare will benefit America's peacetime activities in this field. Our radio development has been, for the most part, directed toward the use of higher-frequency equipment. First came broadcast long-wave radio, then short-wave radio, and then FM. This trend was accelerated by the laboratory work on radar, television telemetering, and certain continuous-wave techniques. These efforts represent the very developments which will improve greatly our postwar communications and television, as well as other branches of electronics.



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the Finish on
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Until you have that new car... be proud of your old one. SIMONIZ it for protection against winter weather . . . against slush, mud and freezing cold. Saves car trade-in value, too. Simoniz Kleenex, liquid or paste, restores dull finishes to shiny newness . . . SIMONIZ keeps it sparkling, eliminates frequent washings. Easy to use . . . gives beauty and protection months longer. Don't let winter ruin your car's finish . . . SIMONIZ today!

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SIMONIZ

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That's the way all America's going . . . toward ultra-lightness with magnesium! . . . ★ You're very likely to find magnesium in a fine new portable typewriter . . . designed, styled, constructed in the best tradition of today. Take hold of the handle! Incredibly light! Lifts like a dream, to desk or shelf . . . swings lightly in your hand when you're off down the street. Strong and durable, too, this extraordinary metal—worth whatever slight price premium it may entail. ★ Dow, of course, is not in the typewriter business. But the hundreds of diversified manufacturers with whom this foremost magnesium producer cooperates are planning now to bring you new and better lightweight products of many kinds.

Ready... to make products move!

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LIGHTEST OF ALL STRUCTURAL METALS



Metal from the sea, and from ocean brine wells, too, is exact in abundant quantities now, the nation's foremost magnesium producer.



Best magnesium fabrication techniques are developed by Dow in cooperation with many skilled and experienced fabricators throughout the country.



Mighty industrial applications and fine consumer products are included in the growing list of magnesium items made through Dow cooperation.



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to deliver **FULL POWER!***

**TO CLEAN OUT
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**TO KEEP IT
CLEAN**

Sludge, gum and acid accumulations create abnormal conditions and "foul up" engine parts. **LOOSITE**, a basic cleaner, rids the engine of all sludge and gum. It reaches valves, rings and pistons; restores their real efficiency. It is safe, easy and economical to use.

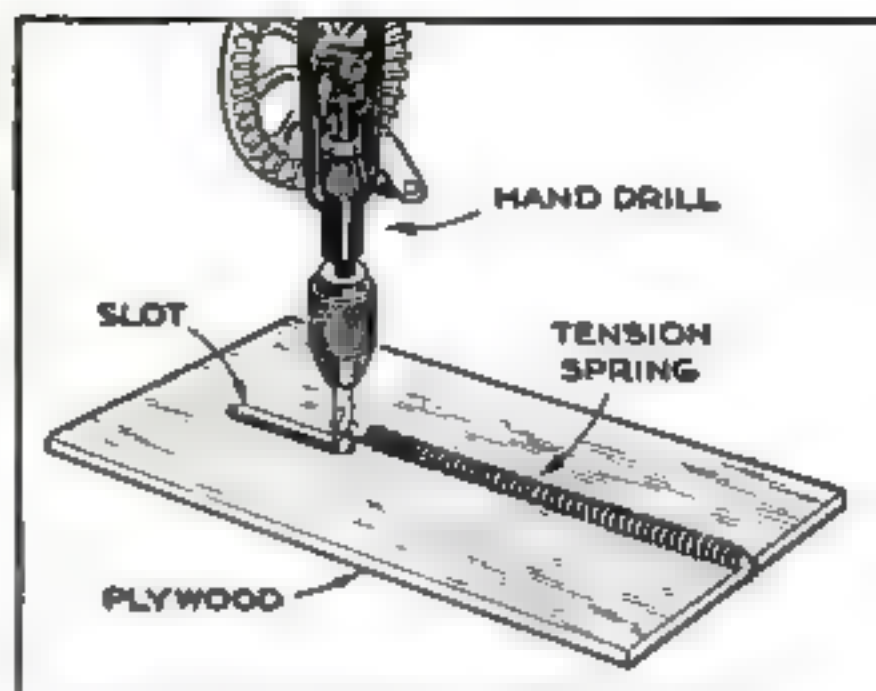
After one **LOOSITE** treatment, a can of **SILOO** added with each change of crankcase oil, keeps your engine clean by dissolving immediately any new sludge formations. **SILOO**, the seven-solvent compound with four inhibitors, becomes an integral part of the lubricant itself—cannot be removed by any standard filter. This is important.

A **LOOSITE-SILOO** treatment will show immediate results on any make and model car—regardless of quality or brand of oil used. Fifteen years of service endorses its use.

SOVENTS FOR ALL TYPES OF PETROLEUM RESIDUES
Petroleum Solvents
CORPORATION

General Offices: 331 Madison Ave., N. Y. 17, N. Y.
Plant and Laboratories: Port Reading, N. J.

**If you heat with oil — write for information on
SILOO FUEL OIL TANK SOLVENT**

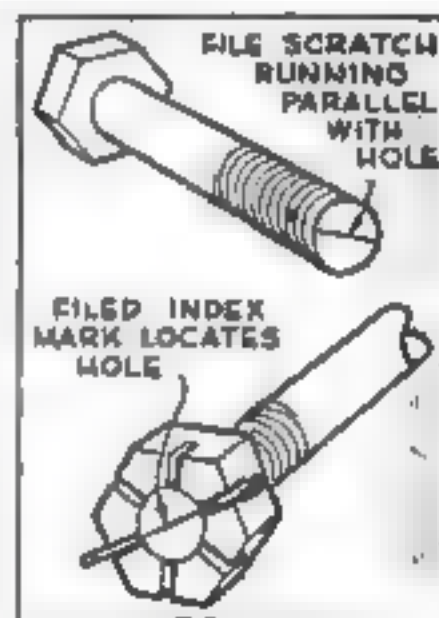


Hand Drill Cuts Slot in Plywood

WHEN a slot is needed in plywood, the job can be done with a hand drill and a tension spring. Drill a hole at the point where you want one end of the slot, hook the spring over the drill and the end of the board, and operate the drill.—RONALD EYBICH.

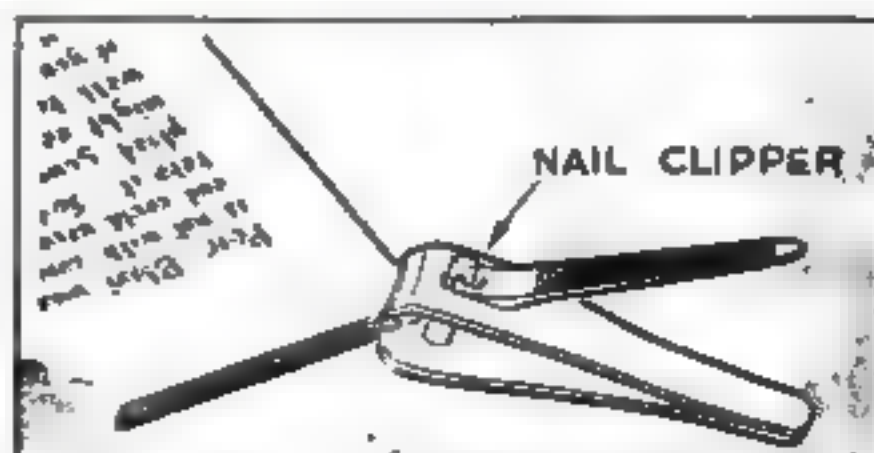
Scratches Mark Cotter-Pin Holes

FILE marks across the ends of bolts parallel with cotter-pin holes afford a positive way of locating the holes, especially when they are hidden by grease or dust. When a castellated nut is used, the hole is quickly brought into line by turning the nut until the mark is between castles.—J. K.



Nail Clipper Rounds Book Corners

SQUARE corners of booklets that have become worn and curled can be neatly rounded with an ordinary nail clipper. It will cut several pages simultaneously.—FRANK SHORE.





RCA's new television camera has a super-sensitive "eye" that sees even in the dimmest light—indoors or outdoors.

A television camera "with the eyes of a cat"

As a result of RCA research, television broadcasts will no longer be confined to brilliantly illuminated special studios.

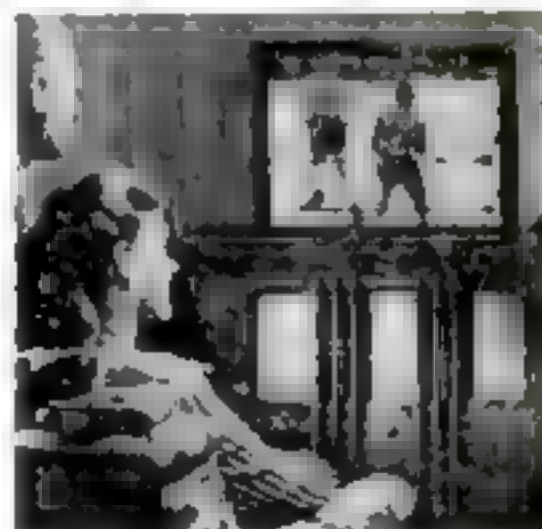
For RCA Laboratories has perfected a new television camera tube, known as Image Orthicon. This tube can pick up scenes lit by candlelight, or by the light of a single match!

Operas, plays, ballets will be televised from their original performances in the darkened theater. Outdoor events will remain

sharp and clear until the very end!

From such research come the latest advances in radio, television, recording. RCA Laboratories is your assurance that when you buy any RCA product you become the owner of one of the finest instruments of its kind that science has achieved.

Radio Corporation of America, RCA Building, Radio City, New York 20. Listen to *The RCA Show*, Sundays, 4.30 P.M., Eastern Time, over the NBC Network.



RCA Victor television receivers with clear, bright screens will reproduce every detail picked up by the RCA television camera. Lots of treats are in store for you. Even today, hundreds of people around New York enjoy regular boxing bouts and other events over NBC's television station W NBT.



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PLASTIC PLIERS

- Weighs 1½ ounces!
- Absolutely shock-proof non-magnetic!
- 6,000 volt breakdown!
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- Tensile strength of material, 5000 lbs. per square inch!
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- Relocate wiring without disturbing magnetic fields while equipment is operating!

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1

DEPT. A-1

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FOR JOINING & CUTTING MOLDINGS



With our six inch tool steel cutters make moldings casings drop leaf tables grooves beading and jointing. Moulding cutters A 1 in. wide \$1.50, 1½ in. \$1.75, Joining cutters, B 1 in. \$1.50, 1½ in. \$1.75, C 1 in. for drop leaf tables \$1.50, E 1½ in. Makes ¾ in. cove & Quarter \$1.75. Postpaid. Guaranteed. State also how List & Folder free.

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Mt. 1-P. Clearwater, Fla.



HANDY ELECTRIC TEST-LITE

Instantly Tells if Circuit is Broken!

Electric trouble shooter with hundreds of uses. Locates blown fuses, late appliances, motors, spark plugs, electric fuses, grounded lines, cables, etc. Neon indicator shows on voltage from 60 volts AC to 600 volts AC or DC. A necessity for experimenting. Complete instructions easy to use. Satisfaction guaranteed. Available from dealers or by postpaid by return mail. Address Dept. A.

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Makes OLD DRILLS AS GOOD AS NEW

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T & H Mfg. Co., B11-E, East 31st, Kansas City 3, Mo.



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350 CUTS PER MINUTE

Make money sawing wood. Use Ottawa—fastest cutting. Cuts large, small logs easiest way. Fells trees. One man operates. Thousands in use. Built to last with heavy, stiff saw blade. Positive safety clutch control; uses power take-off any tractor. OTTAWA MFG. CO., B101 Forest Ave., Ottawa, Kan.

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BARGAINS in WAR SURPLUS LENSES & PRISMS



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In order that the tank driver shall not get shot in the face, 2 of these Silvered Prisms are used to make a Periscope. We have secured a number of these 90-45-45 degree Prisms of huge size—5 3/4" long 2 1/2" wide, finely ground and polished. Used to build a Periscope camera stereo attachment, range finder etc. Excellent also for experiments, classroom demonstrations. Prism easily converted into desk name plate by affixing gold letters. 100 gold letters supplied at only 10c (Order STOCK = 3008-N). Normally these Prisms would retail from \$24 to \$30 each.

SILVERED TANK PRISM

Stock # 3004-N \$2.00 each Postpaid

PLAIN TANK PRISM

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FOUR TANK PRISMS—Special—\$7.00 Postpaid

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\$141.01 WORTH OF PERFECT LENSES
FOR ONLY \$10.00

Complete System from Artillery Scope (5X) 9 Lenses, low reflection coated absolutely Perfect. Diameters range from 1 1/2 inches to 2 1/5 inches. Used for making Telescope and hundreds of other uses.

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from 1 to 10. Various diam. for many uses

Free Booklet on Home-made magnifiers included

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ALL THE LENSES YOU NEED TO MAKE YOUR OWN

TELESCOPE! ALL ARE ACHROMATIC LENSES

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All Items Finely Ground and Polished but Edges Slightly Chipped or Other Slight Imperfections which We Guarantee Will Not Interfere with Their Use. Come Neatly Packed and Marked.

YOU CAN EASILY MAKE

Telescopes, Magnifiers Photographic Gadgets and Hundreds of Experiments with these Low Cost Lenses.

To translate millimeter measurements, 25.4 mm. equals one inch.

SPECIALS IN LENS SETS

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4009-N	Heat Absorbing Glass 4" x 5"35 each
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24-N	First Surface Aluminized Mirror, Diam 1 1/2"25 each
624-N	Neutral Ray Filter size 4 1/2" x 2 1/2"25
524-N	Inclinometer—Aircraft type25 each
704-N	Lens Cleaning Tissue one ream (450 sheets) size 7 1/2" x 11"	1.00
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1031-N	Perfect 8 Power Magnifier—Diam. 28 mm.25 each
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Complete Set Mounted Components

Have fun! Make a real Periscope. Use it to see over the heads of crowds, to see under water, to see out windows without yourself being seen, and many other uses where observation by remote control is required. Originally constructed for U. S. Army Tanks, set consists of 2 fine Periscope mirrors mounted in metal and plastic. Perfect condition. Only plywood body frame is required to finish this exceptional Periscope. Set weighs 2 1/2 lbs. Overall length 6 1/2" width 2 1/2". Would normally retail at \$40 to \$50. Stock # 700-N \$3.00 Complete Set Postpaid (Two Sets (four units) . . . Special \$5.50 Postpaid.)

Order by Set or Stock No. • Satisfaction Guaranteed • Immediate Delivery

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NEXT TIME SAY BRIGHT STAR

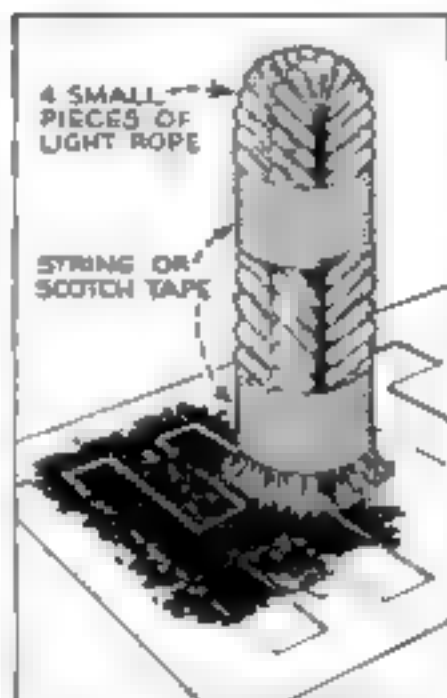
and you will get a
FLASHLIGHT & BATTERIES
famous since 1909
for QUALITY,
STYLE and
SERVICE



BRIGHT STAR BATTERY CO. CLIFTON N. J.

Stencil Brush Made of Light Rope

Two pieces of light rope will serve as a satisfactory stencil brush if a regular one is not available. Cut the two pieces to equal length, loop them side by side so that the cut ends coincide, and bind together with string or scotch tape as indicated. Then form bristles by fraying the rope ends.—N. P. G.



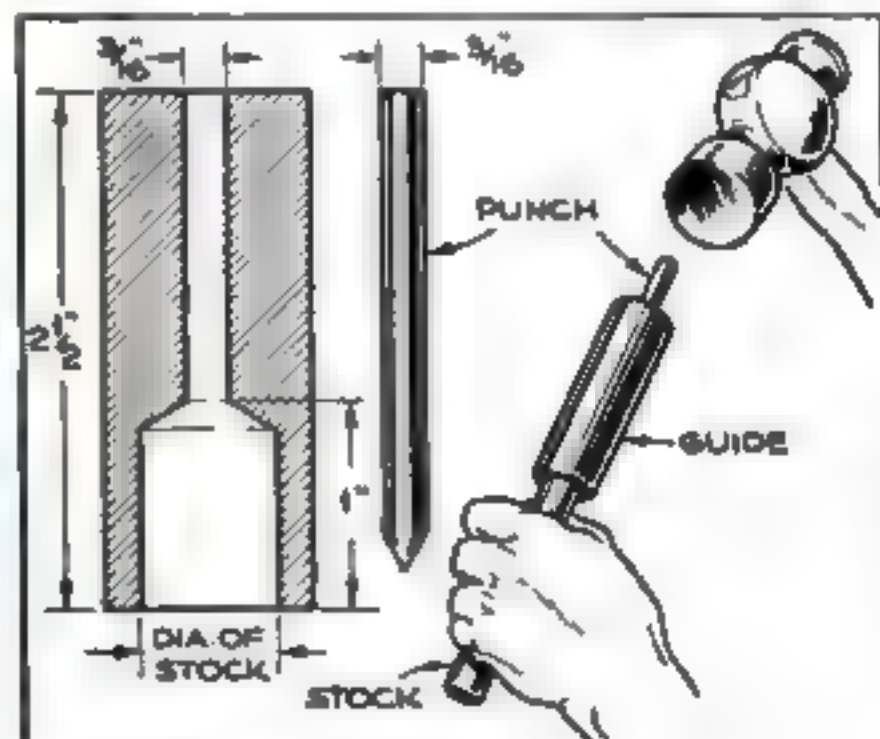
Purse on Quiver Holds Arrowheads



WHEN a person is hunting or target shooting with a bow and arrows, a zipper coin purse or wallet sewed against the side of the quiver makes a handy pouch for carrying extra arrowheads. A wallet with a slide fastener also could be used.—E. P. B.

Guide Finds Center of Round Stock

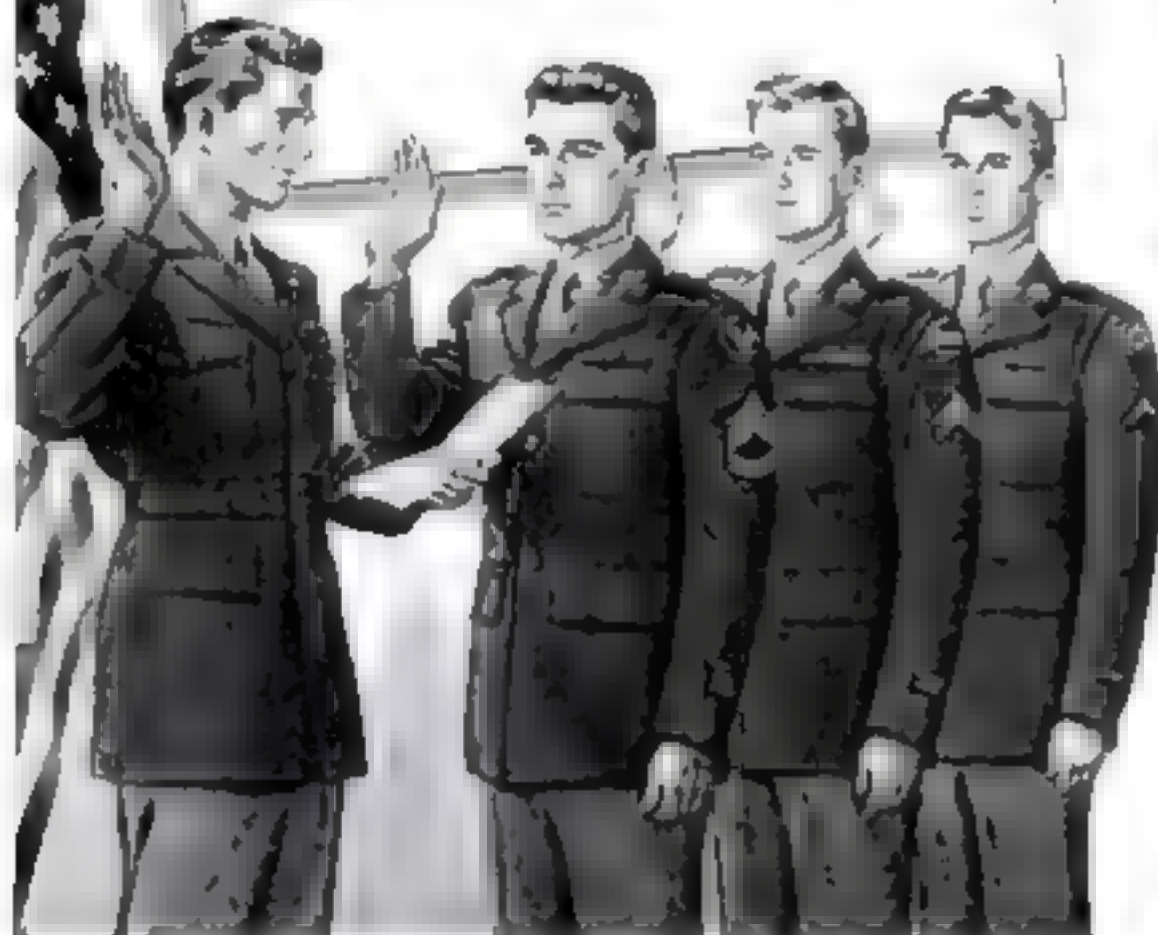
SEVERAL guides made out of steel as indicated in the accompanying diagram enable me to locate the center of wood or metal round stock with ease. The interior diameters vary to fit different sizes of stock. If preferred, one large guide could be made and bushings used.—R. E. BELLINGER.



January 31

THE LAST DAY

**for men now in the Army
to retain their present
grades by reenlisting...**



HIGHLIGHTS OF THE NEW ENLISTMENT PROGRAM

1. Enlistments for 1½, 2 or 3 years. (1-year enlistments permitted for men now in the Army with 6 months' service.)

2. Enlistment age from 17 to 34 years inclusive, except for men now in Army, who may reenlist at any age.

3. Men reenlisting retain their present grades, if they reenlist within 20 days after discharge and before February 1, 1946.

4. The best pay scale, medical care, food, quarters and clothing in Army history

5. An increase in the reenlistment bonus to \$50 for each year of active service since such bonus was last paid, or since last entry into service.

6. Up to 90 days' paid furlough, depending on length of service, with furlough travel

paid to home and return, for men now in Army who enlist.

7. A 30-day furlough every year at full pay.

8. Mustering-out pay (based upon length of service) to all men who are discharged to reenlist.

9. Option to retire at half pay for life after 20 years' service—or ¾ pay after 30 years' service. All previous active federal military service counts toward retirement.

10. Benefits under the GI Bill of Rights.

11. Family allowances for the term of enlistment for dependents of men who enlist before July 1, 1946.

12. Opportunity to learn one of 200 skills and trades.

13. Choice of branch of service and overseas theater in the Air, Ground or Service Forces on 3-year enlistments.

Men now in the Army who reenlist before February 1 will be reenlisted in their present grade. Men honorably discharged can reenlist within 20 days after discharge in the grade they held at the time of discharge, provided they reenlist before February 1, 1946.

There's a long list of attractive reenlistment privileges in the new Armed Forces Voluntary Recruitment Act of 1945. The ability to keep your present grade is only one of them, but this privilege expires on January 31.

There are plenty of other reasons why many thousands of men have enlisted, and more thousands are enlisting every day. You'll certainly want to know all of the opportunities open to you. If you'll read them carefully, you'll know why a job in the new peacetime Regular Army is being regarded today as "The Best Job in the World."

PAY PER MONTH—ENLISTED MEN

In Addition to Food, Lodging, Clothes and Medical Care

	Starting Base Pay Per Month	MONTHLY RETIREMENT INCOME AFTER:	
		20 Years' Service	30 Years' Service
Master Sergeant or First Sergeant	\$138.00	\$89.70	\$155.25
Technical Sergeant	114.00	74.10	128.25
Staff Sergeant	96.00	62.40	108.00
Sergeant	78.00	50.70	87.75
Corporal	66.00	42.90	74.25
Private First Class	54.00	35.10	60.75
Private	30.00	32.50	56.25

(a)—Plus 20% Increase for Service Overseas.

(b)—Plus 50% if Member of Flying Crews, Parachutist, etc.

(c)—Plus 5% Increase in Pay for Each 3 Years of Service.



AIR FORCES • GROUND FORCES • SERVICE FORCES

Reenlist now at your nearest U. S. Army Recruiting Station



STOP DUST



- Dustless
- Speed Sweep
- Speed Wash brushes

MILWAUKEE DUSTLESS BRUSH COMPANY

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MEN WANTED!

**GOOD MONEY NOW and
a Bright POST-WAR FUTURE**

Returning Veterans, office and factory workers, others! If you want to enjoy a FINE INCOME NOW with even greater opportunities in the future, write us today! We are a nationally known manufacturer of Fire Fighting equipment, including AUTOFYRSTOP, the amazing combination fire extinguisher and alarm that holds unequalled records. Our products sell FAST and in QUANTITIES to factories, schools, stores, homes. NO EXPERIENCE NEEDED. Write for FREE FACTS!

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500,000 OF THEM!! Buy them for a fraction of their original cost. U.S. Army and Navy surplus lenses and prisms. Send 3 cent stamp for list.

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EX ACHROMATIC Telescope set ea. 1.50
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ACHROMATIC OBJECTIVE 1 1/2" Dia. 5" F.L. ea. 1.50
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ANYONE CAN DO THIS IF THEY HAVE OUR CHART

Blue Print 27" x 36" shows how to find length of any rafter. Find any angle in degrees. Frame any polygon 3 to 16 sides, read board feet and brace tables, octagon scale, rafter tables and many other plans. Can be scaled down for model work as well as full scale framing. Also chart changing pitches to degrees for use with Radial Saws. Send 50c in coin or money order. No stamps or checks.

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MEN—do you suffer from dandruff which returns the day or so after you have washed your hair—simple method which takes only a few minutes of your time removes dandruff—no soap or cleaning agent used—results delightful—send 25c to cover instruction and mailing cost to Scalp Treatment, 148 Champion St., Battle Creek, Michigan—Please Print

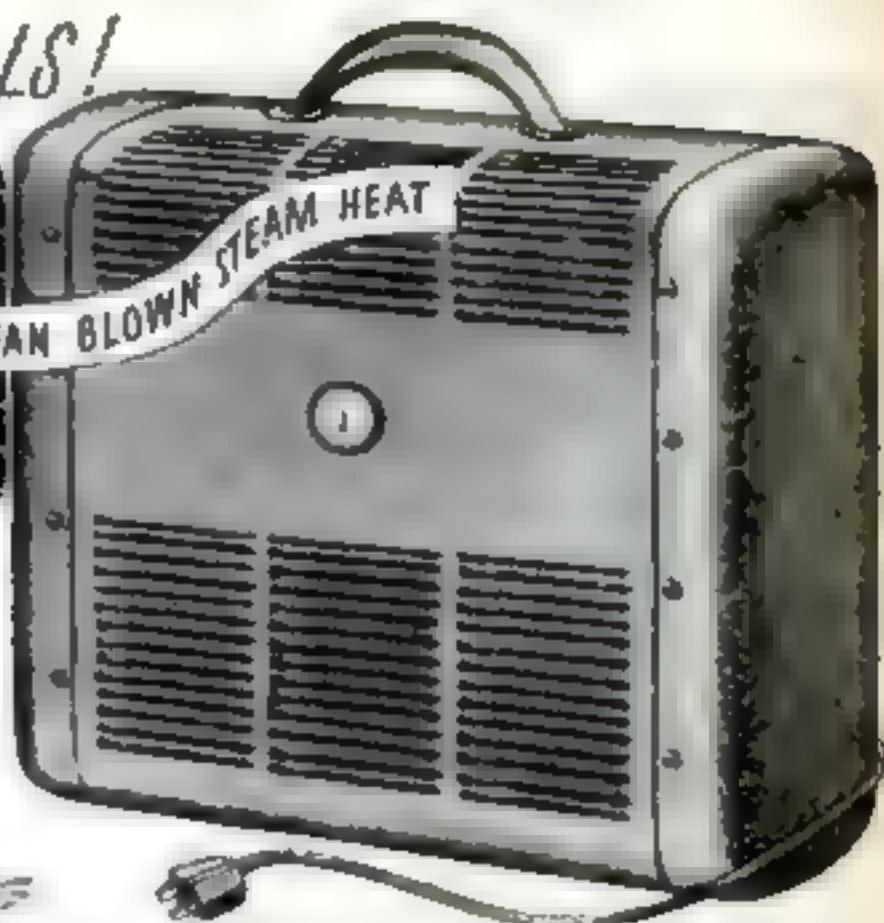
New You Can be TALLER

than "SHE" is!

Adler Elevator Shoes make you almost 2 INCHES TALLER. "Confidentially", and comfortably the instant you put them on. Worn and praised by thousands. Look like any other stylish shoes—no high heels! Write for amazing catalog mailed in plain wrapper Adler, 122 E 42nd St. New York 17, N. Y., Dept. PS-5.

QUICK WARMTH

FOR ROOMS WITH THE CHILLS!



Here is a miracle portable heater that provides real steam heat! It brings comfortably living to chilly rooms, perfect in basements, summer homes and offices.

WITTIE Electric Steam Heater is a wonder compact as streamlined luggage—handsome as a piece of furniture—yet is light enough to carry anywhere. In "Fan Blow" and "Convection" models to suit your needs. Make a date to see these new, low price heaters. Send coupon today.

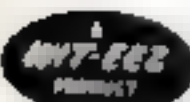
SPECIFICATIONS: 21" x 17 x 7 1/2" inches. Automatic Safety Shut-Off. 2-Stage Heat Regulator. No danger of fire or burn from glowing coils. Costs but a few cents a day to operate, AC or DC. Three colors.



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Please tell me when and where I can see the new WITTIE Electric Steam Heater.

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Chicago 5, Ill.



VanRoy

with the new

Ajustomatic

STEM

*The one and only
Pipe of its Kind*

VanRoy Ajustomatic is more than just another screw-stem. It is a totally new kind of pipe. New—because the patented stem is "flat-mounted"—accurately lines up with the bowl as straight as a die, always. The stem can be turned as often as you like—it will never lock at an off angle. Give yourself, or another, the proud satisfaction of owning this latest—and greatest—achievement in VanRoy pipes.

FREE-TURNING

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SIGNET OF QUALITY IN PIPES

VANROY COMPANY, INC., Empire State Building, New York 1

\$75,000 for boy MODEL BUILDERS

8 UNIVERSITY SCHOLARSHIPS

588 CASH AWARDS

36 CONVENTION TRIPS

Here's the biggest news you've read in a long time. You are eligible to try for these awards in the TWO competitions listed below—if you reside in the United States and are between the ages of 12 and 19 inclusive.

1. **NAPOLEONIC COACH COMPETITION** — 316 awards, including two \$5,000 and two \$3,000 scholarships. In this, you build a miniature model Napoleonic Coach to plans we furnish you.

2. **MODEL CAR DESIGN COMPETITION** — 316 awards, including two \$4,000 and two \$2,000 scholarships. All you do is make a solid model automobile embodying your own ideas of motor-car design.

Rules are simple and fair

In both competitions the following regulations will prevail. Boys 12 years old, or older, but not yet 16 by September 1, 1945, compete in the Junior Division. Boys 16 years old, or older, and not yet 20 on September 1, 1945, compete in the Senior Division. All boys within these age limits are eligible to Guild Membership. There are no dues or entrance fees of any kind. Each member shall receive, without charge, an official Guild membership card and button, and a full set of Guild drawings and instructions. Both competitions close July 15, 1946, and are open to all boys within the age limits, including the sons of General Motors employees. In all cases where the son of a General Motors employee qualifies for an award, duplicate awards will be made.

FISHER BODY CRAFTSMAN'S GUILD

An educational foundation sponsored by

Fisher Body Division of General Motors

General Motors Bldg., Detroit 2, Michigan

Gentlemen: Please enroll me in the Fisher Body Craftsman's Guild for 1946, in the

☐ Napoleonic Coach Competition

☐ Model Car Design Competition

Send me full instructions without charge

Name _____

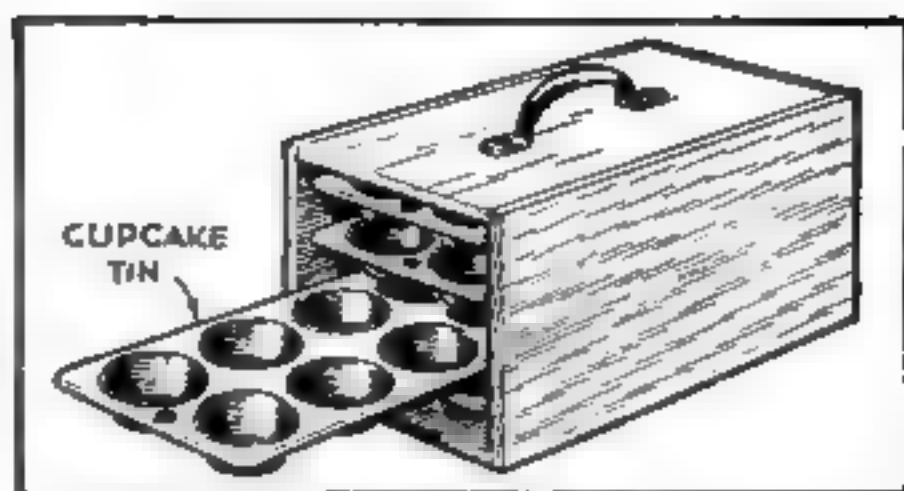
Address _____

City _____ Zone _____ State _____

I was born on the _____ day of _____ 19 _____

Name of parent or guardian _____

Dept. 40



CUPCAKE TINS PROVIDE STORAGE FOR VARIOUS SMALL PARTS

CUPCAKE tins slid like drawers into a wooden box provide convenient receptacles for storage of brads, washers, screws, and other small parts. Strong, nonwarping runners for the trays can be made from the flat type of metal curtain rods.—W. C. IRVING.

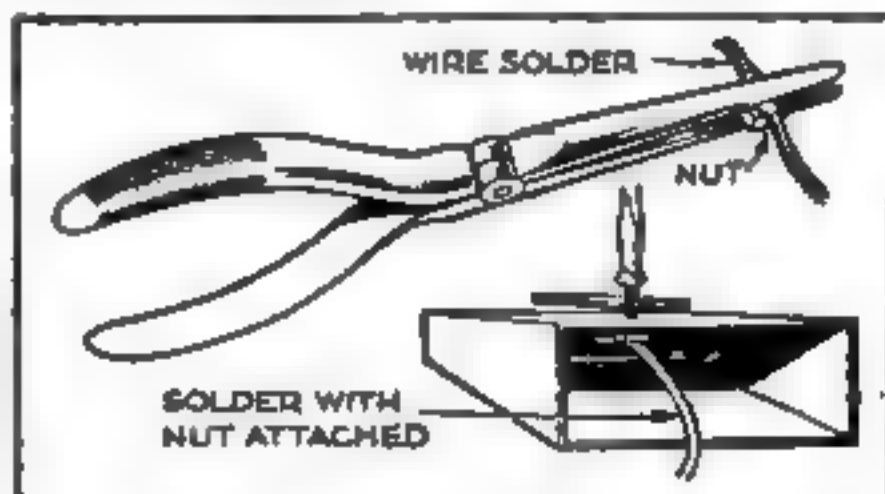


GLASS HOLDER FROM OLD CARTON

AN OLD ice cream carton, particularly one of small diameter, can be put to use by cutting it down as shown in the illustration at the left and tacking it inside the medicine chest to hold a glass. This also could be used in an emergency as a substitute for a regular glass holder.—E. S.

WIRE SOLDER SERVES AS FINGER TO HOLD NUT IN TIGHT SPOT

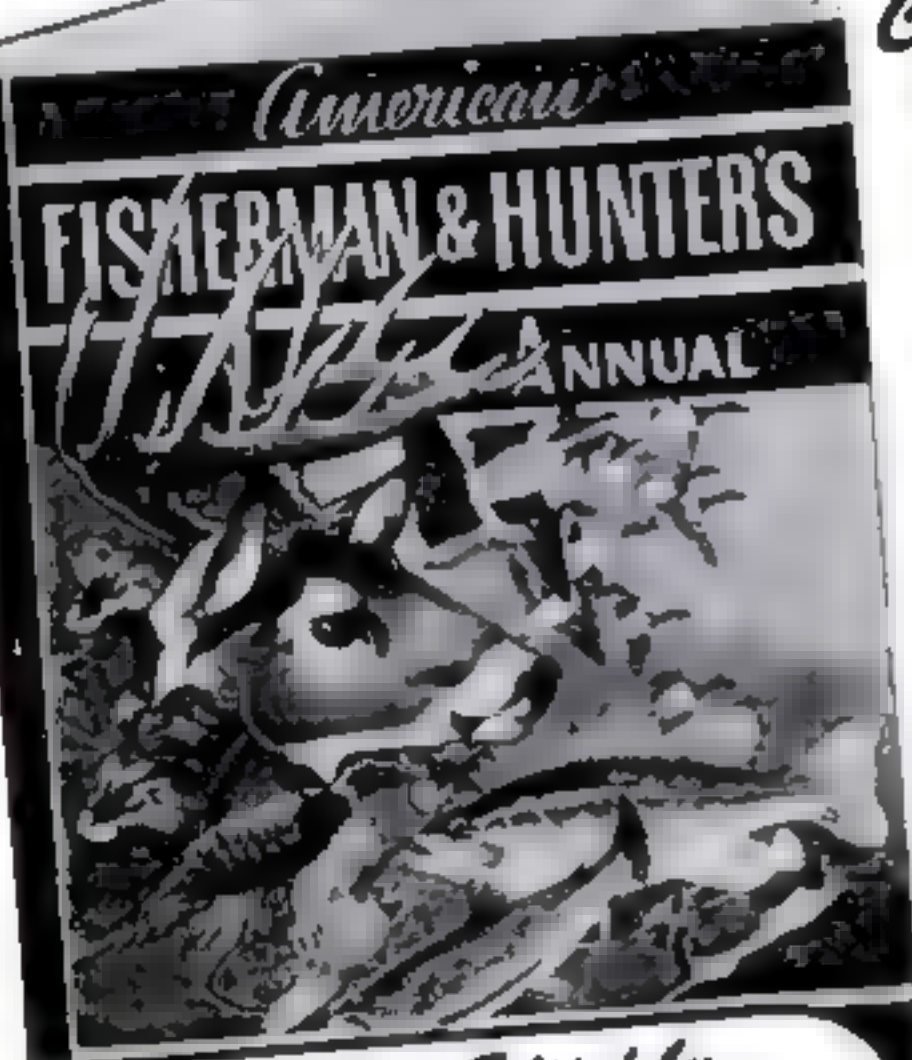
WHEN a nut must be started on a screw in a spot not easily accessible, squeeze a piece of wire solder against the face of the nut with a pair of pliers. Moderate pressure will engage the first thread with the wire. This will hold long enough to thrust the nut into place and get the screw started.—A. O.



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AMERICAN FISHERMAN AND HUNTER'S ANNUAL



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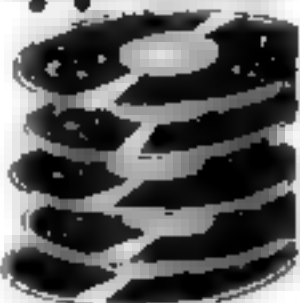
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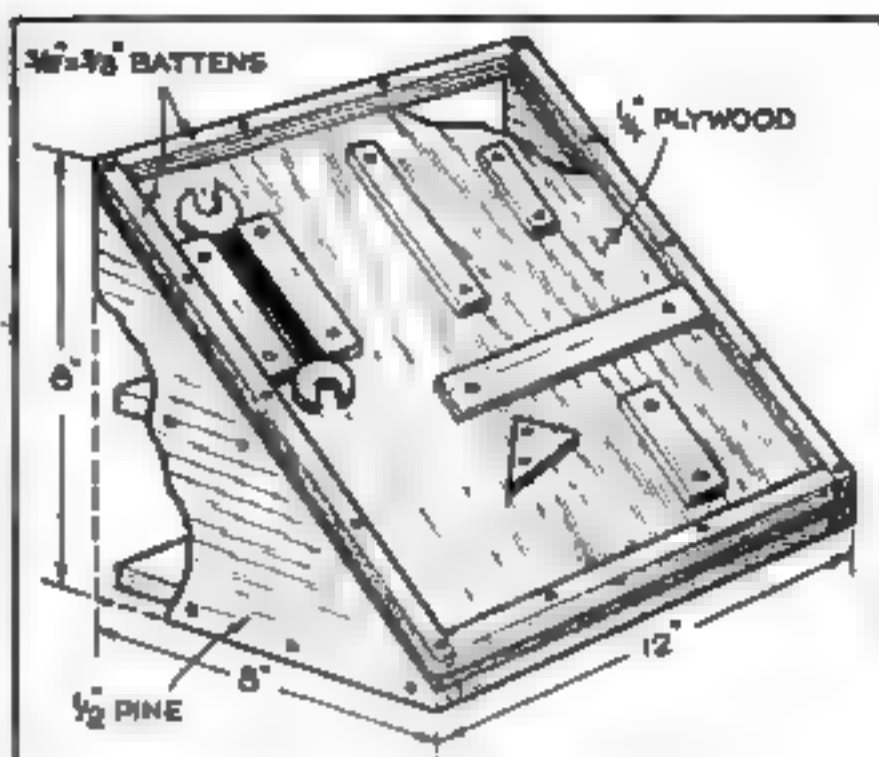
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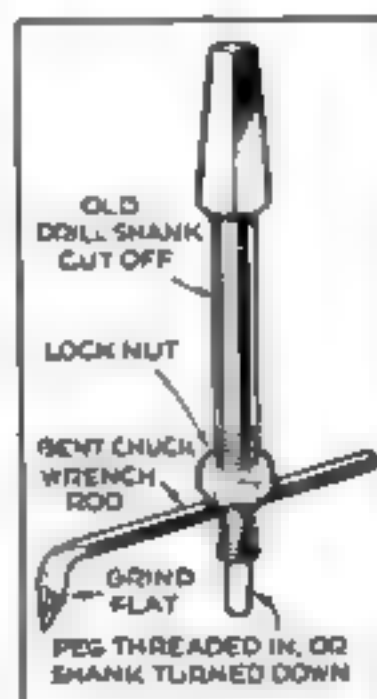
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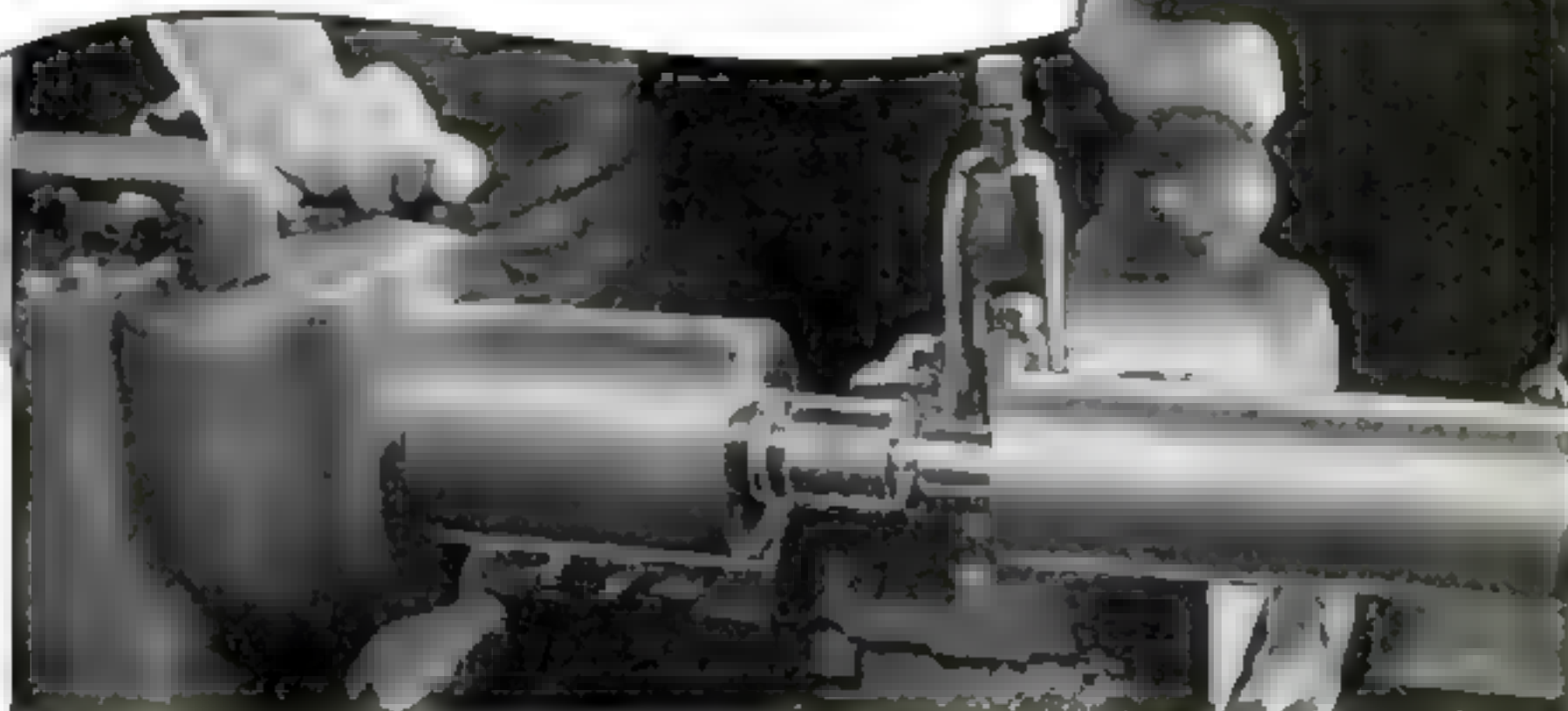
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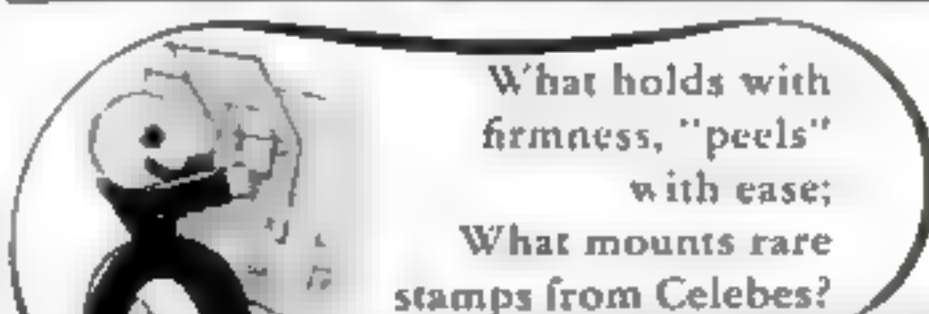
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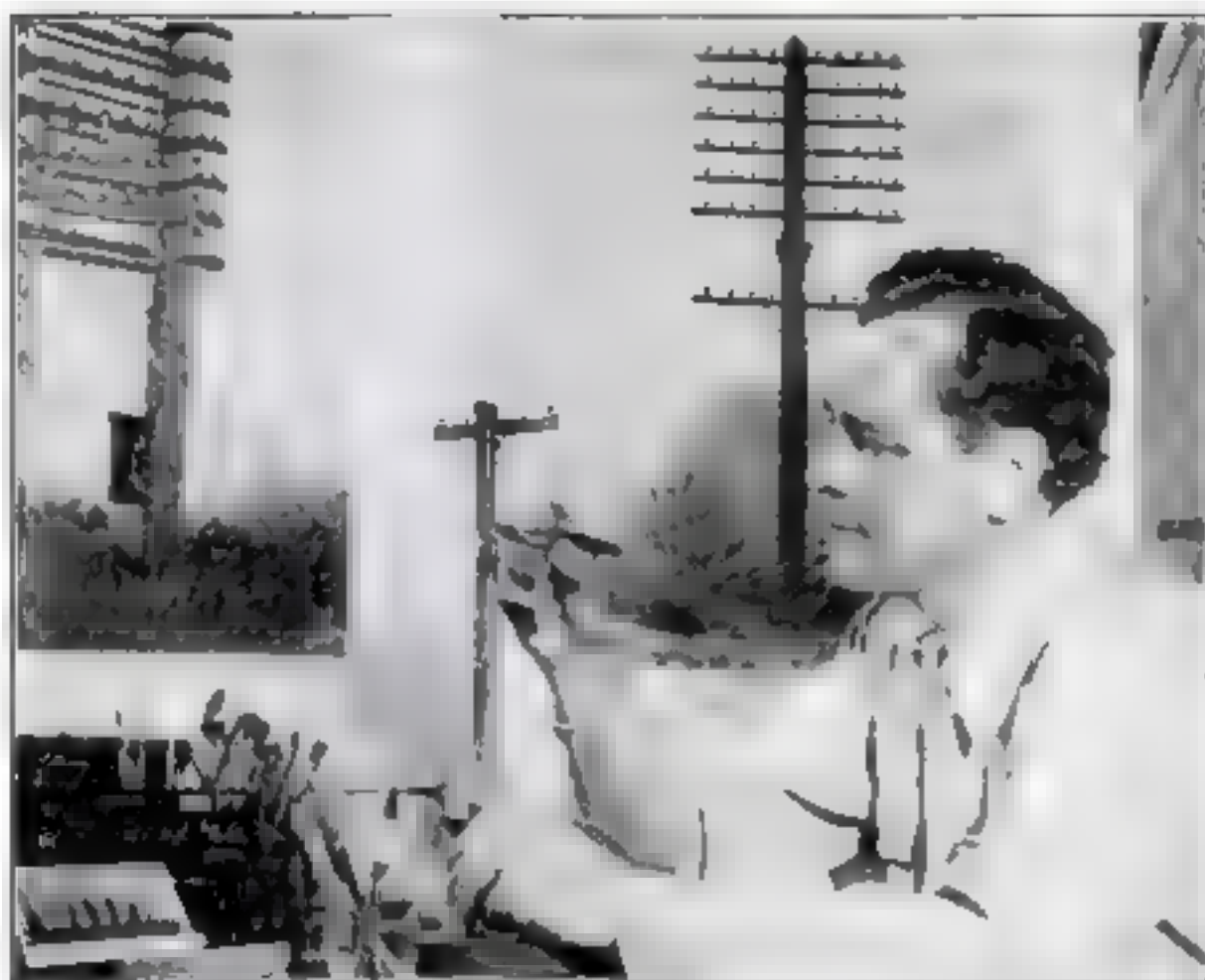


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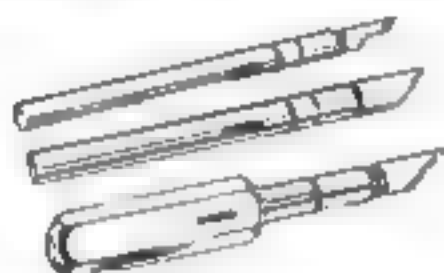
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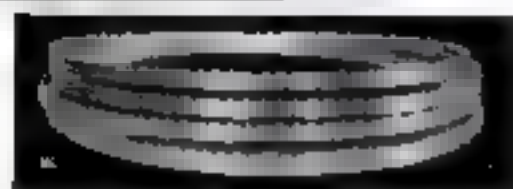
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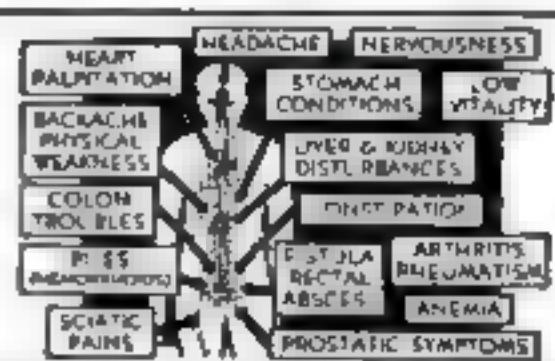


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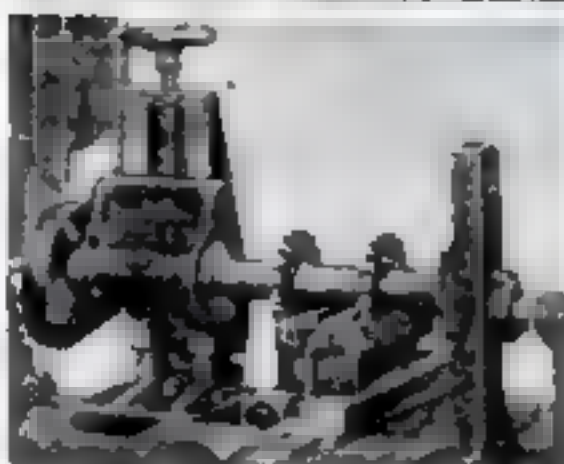
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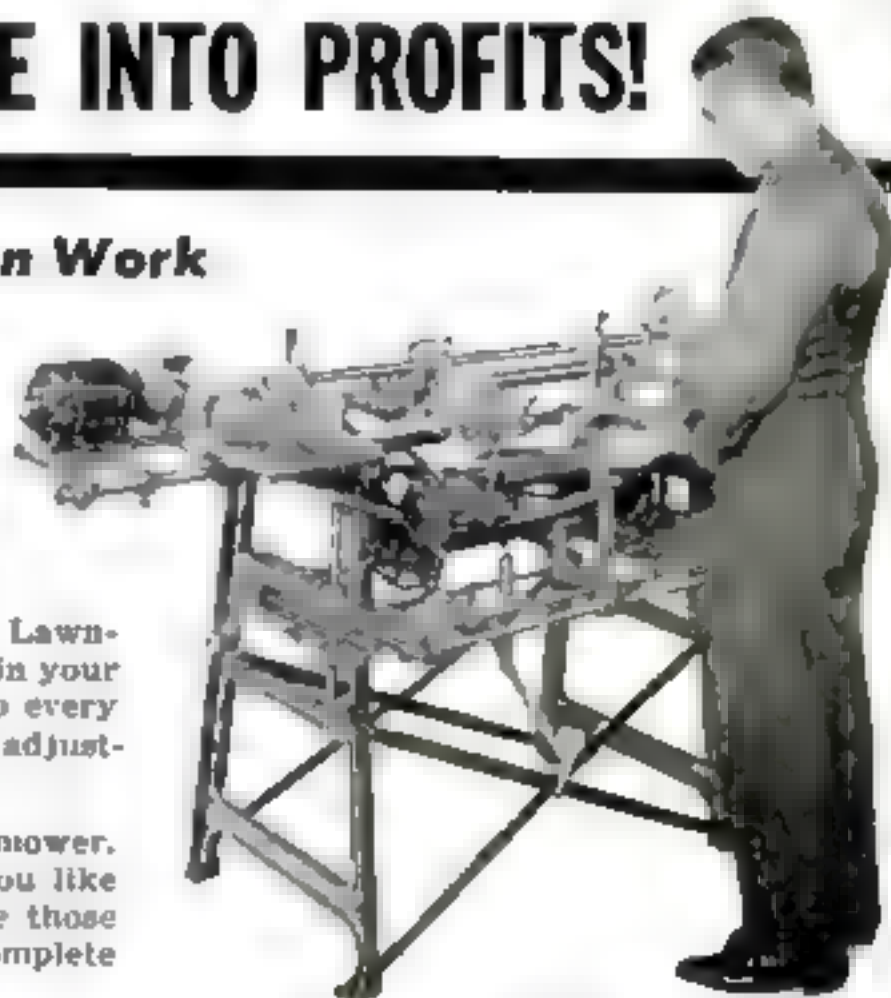
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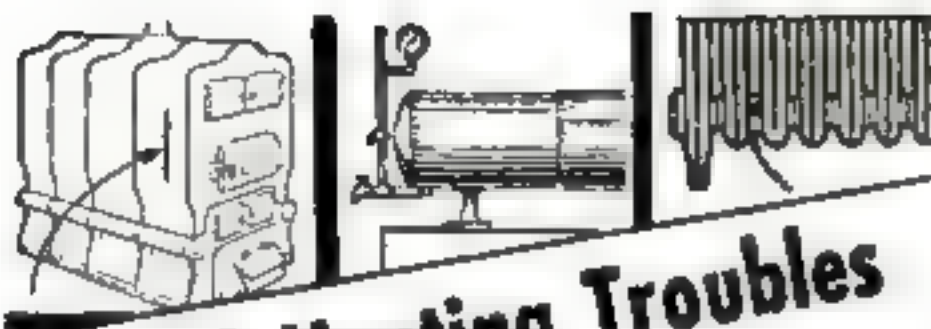
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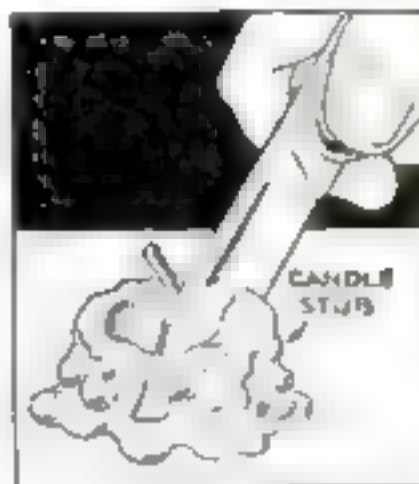
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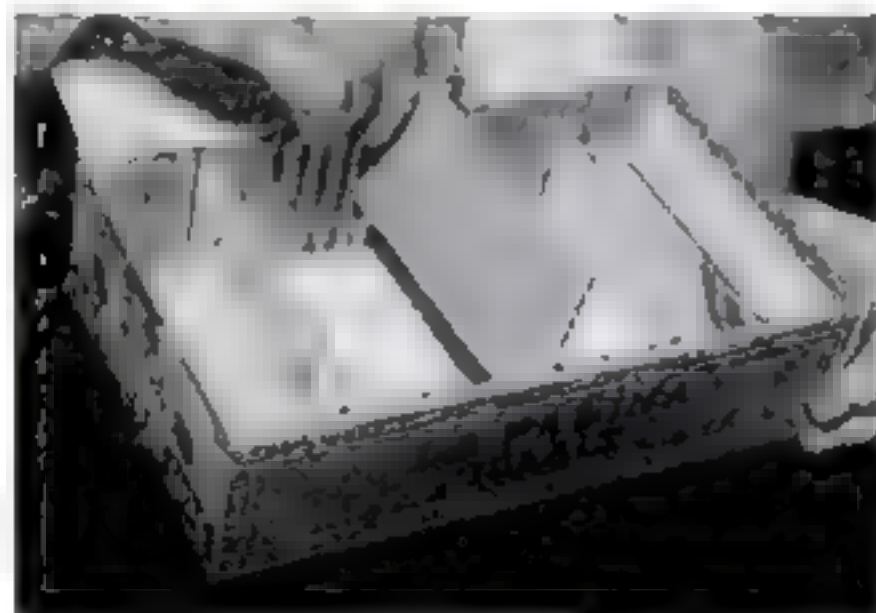
WHEN cutting up cardboard cartons for paper salvage, you can prevent the blade of your knife from binding by keeping it waxed. A candle stub, kept handy on the cutting area, will serve for this.—J. MODROCH.

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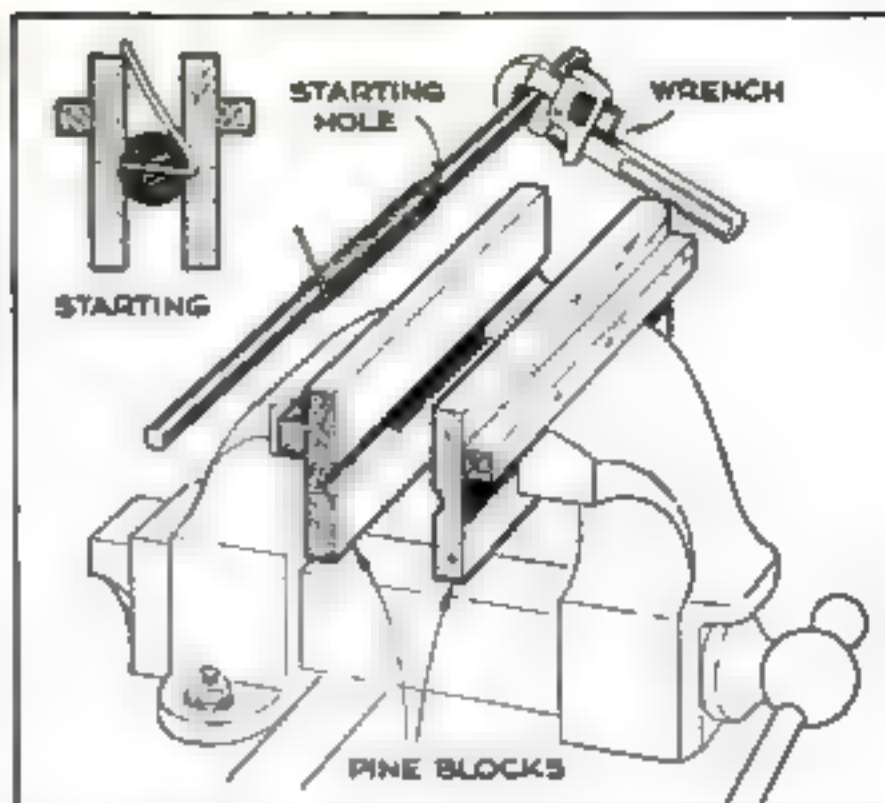
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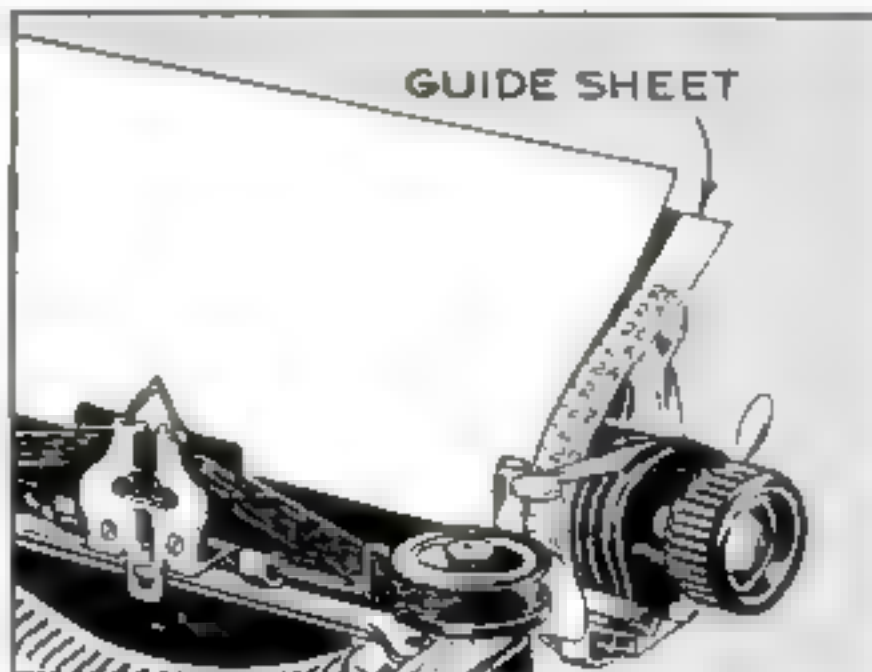
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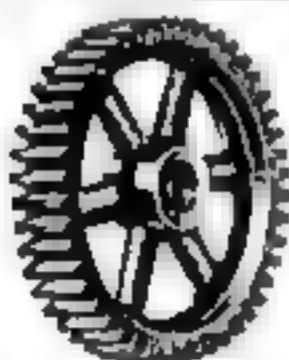


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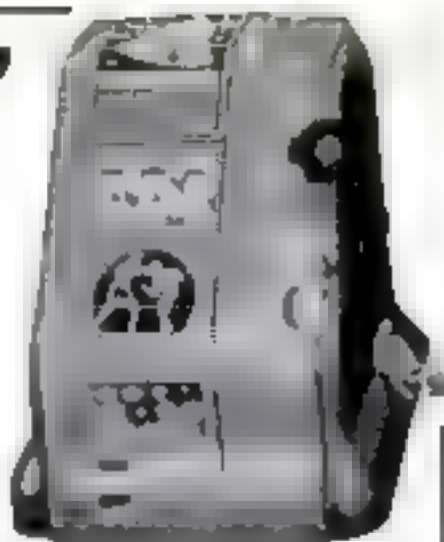
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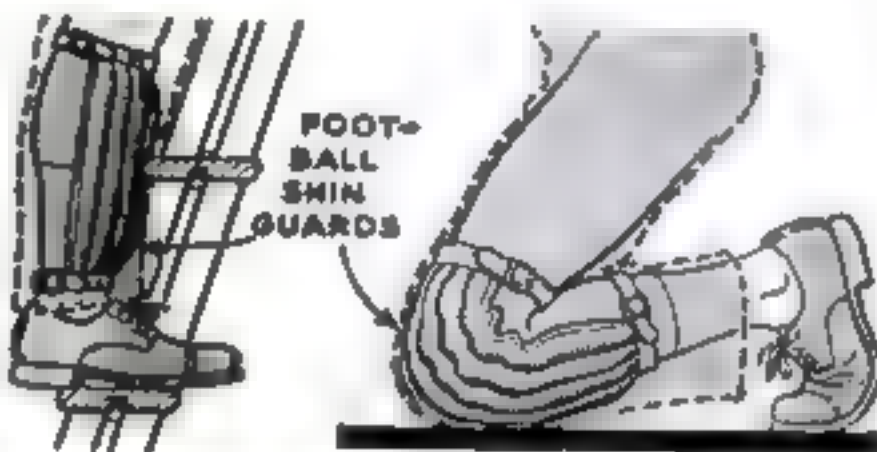
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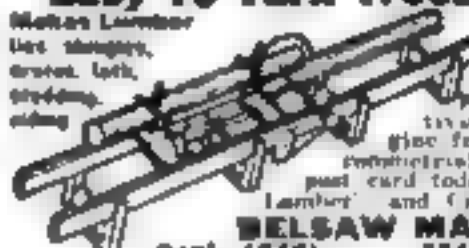
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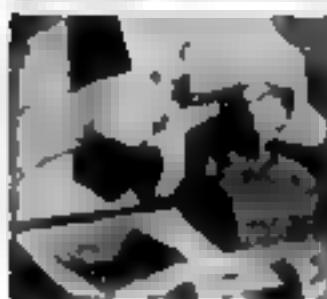
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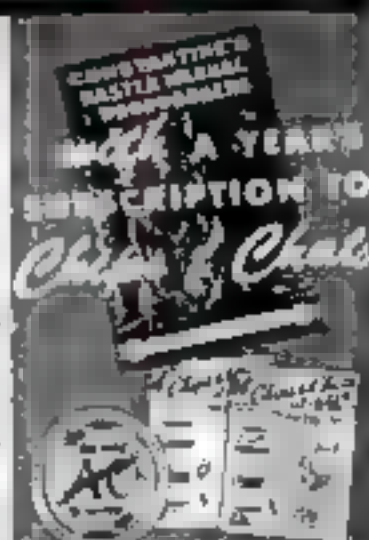


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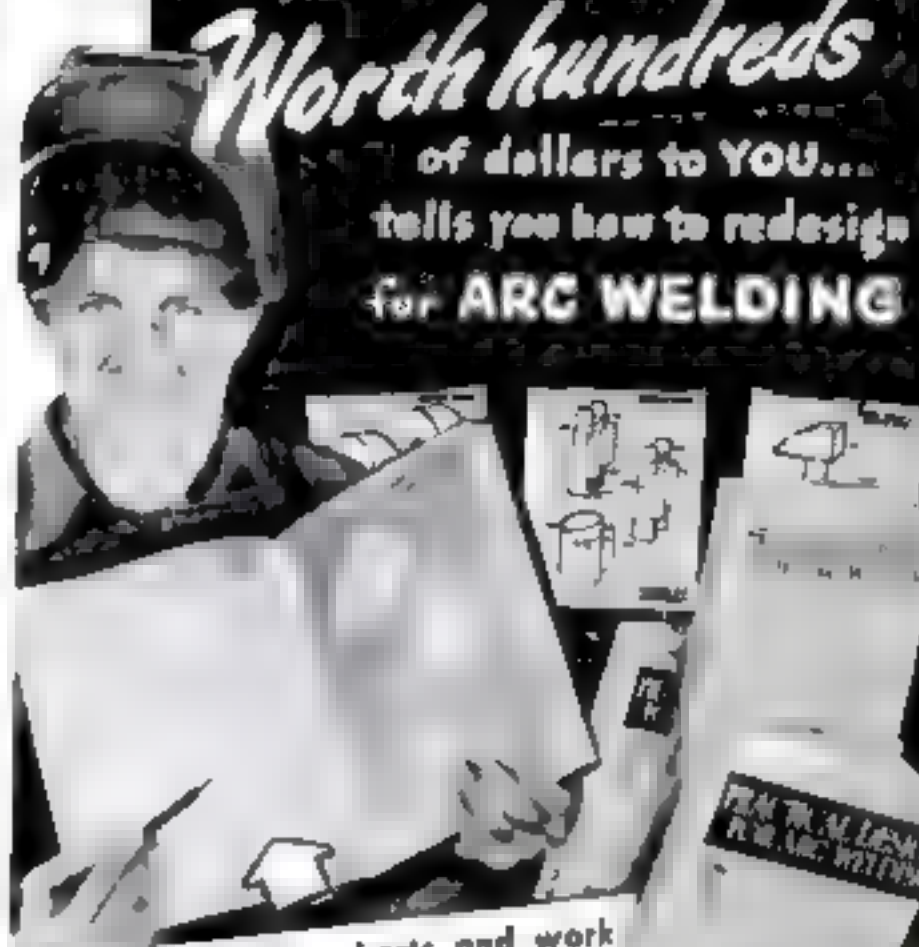
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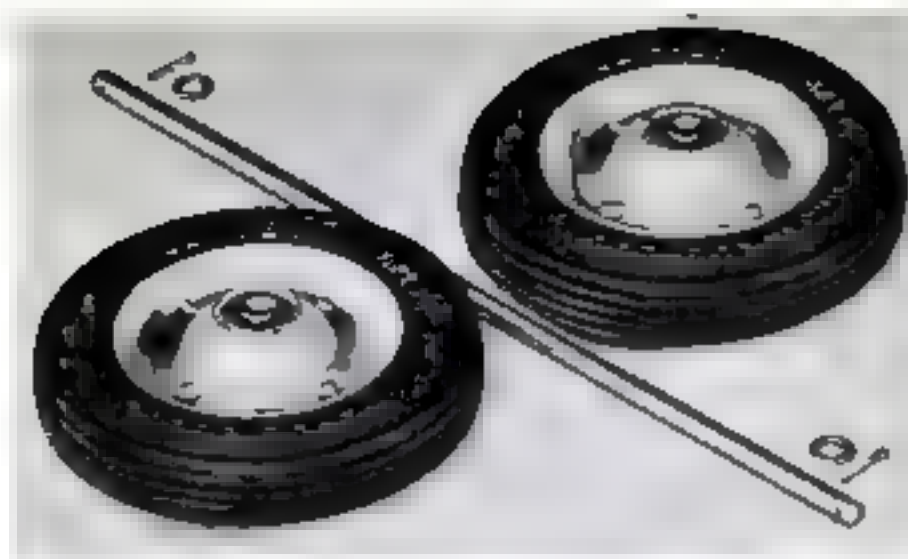
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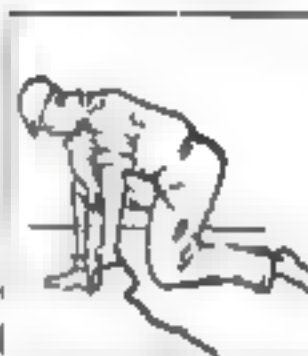
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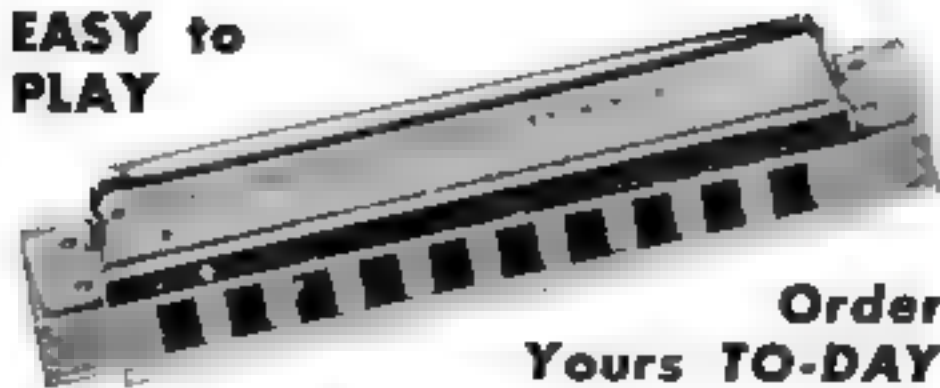
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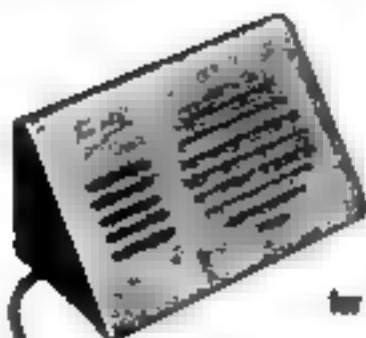
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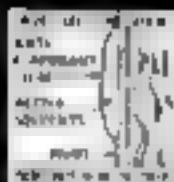
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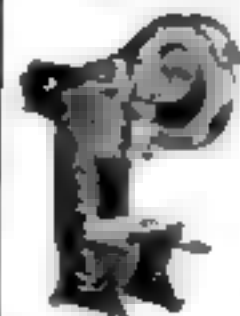
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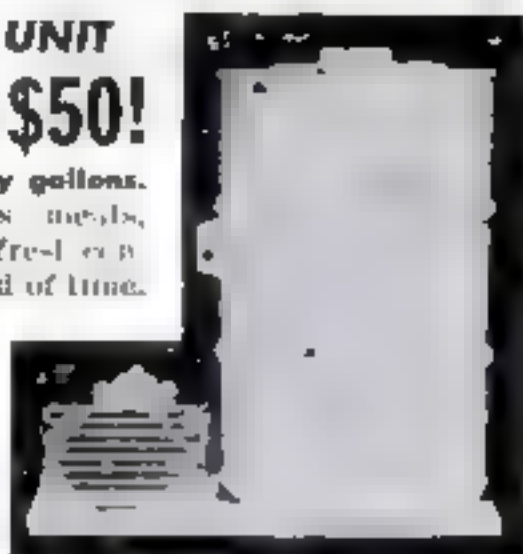
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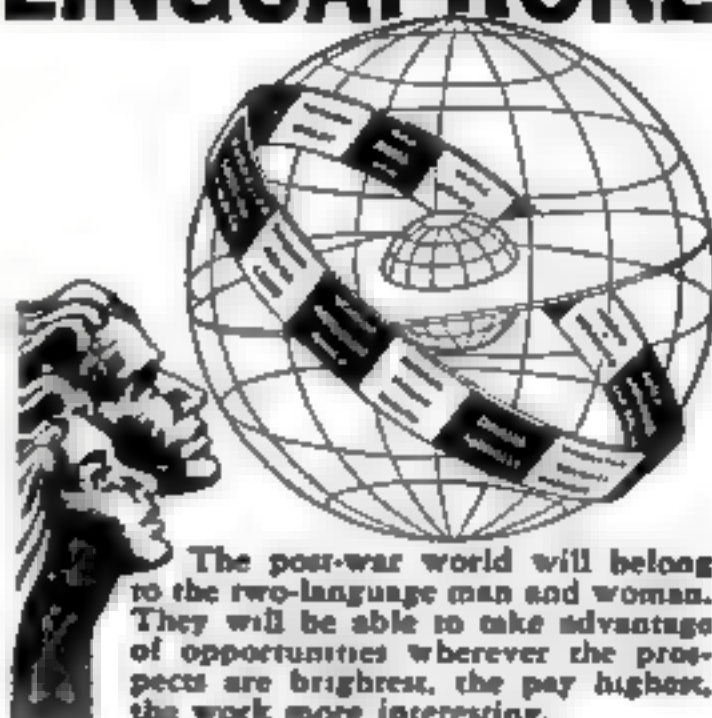
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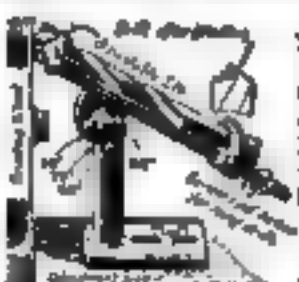
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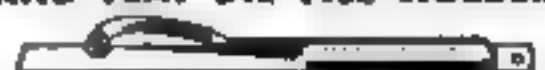
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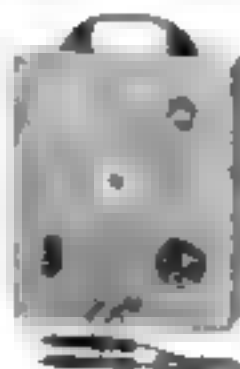
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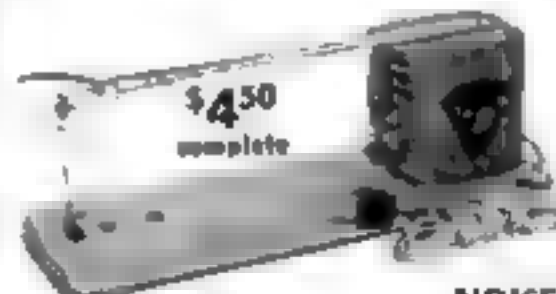
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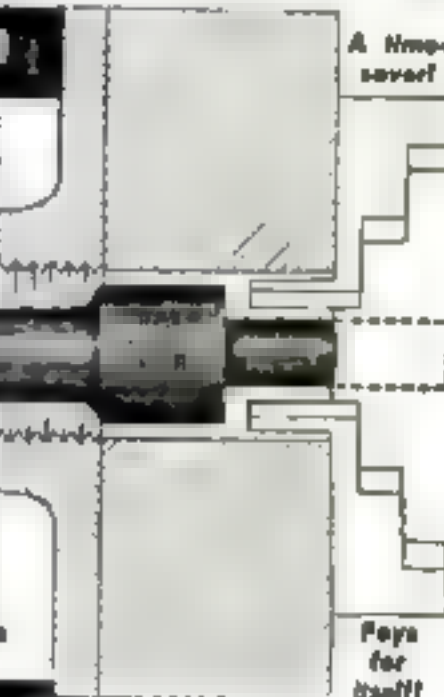
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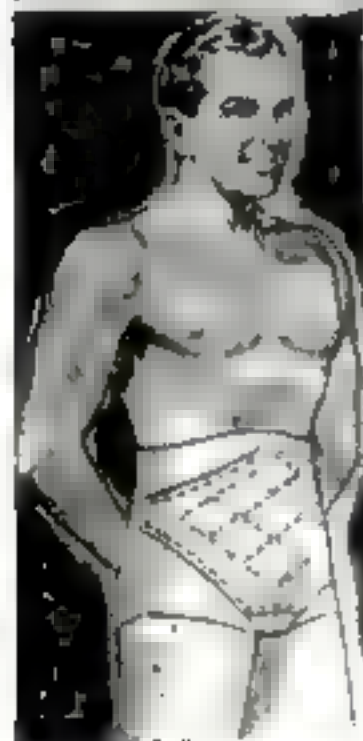
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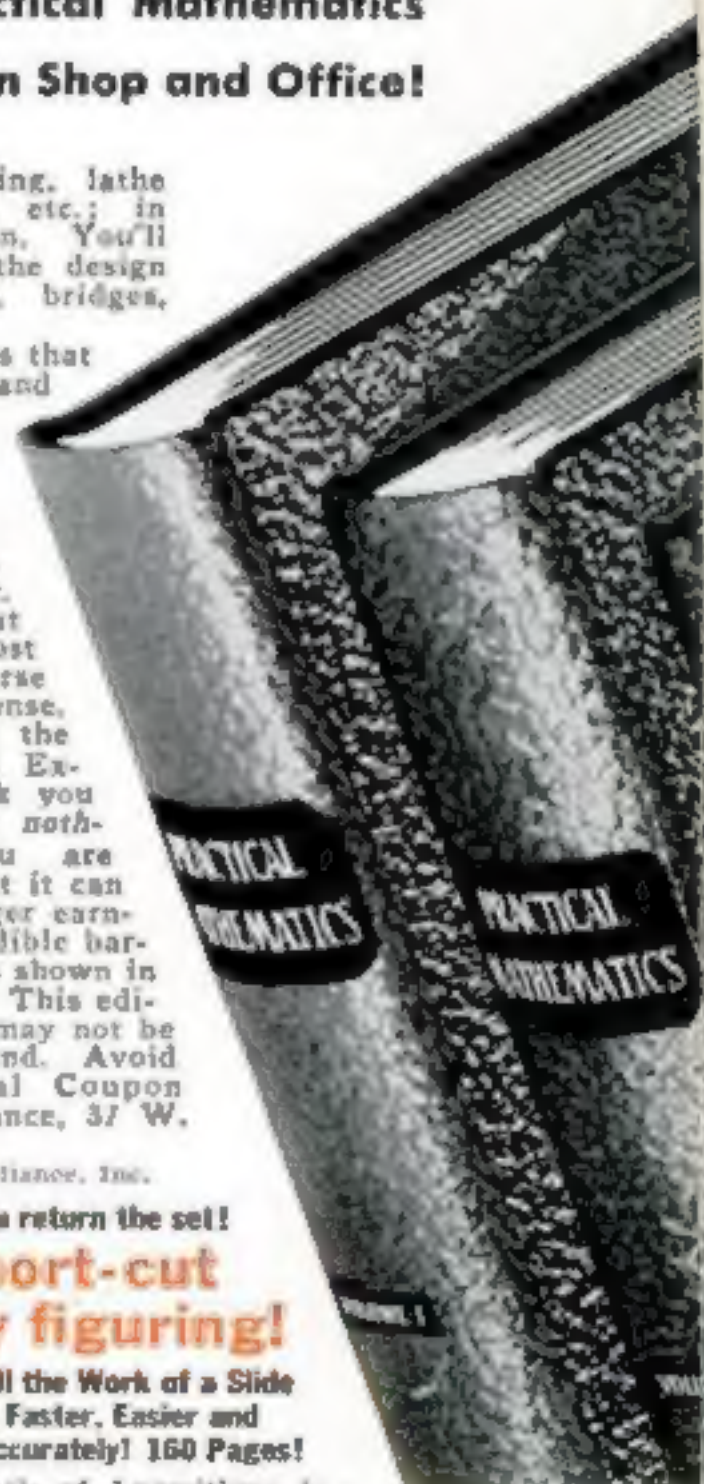
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